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MANAGING ROUTINE EMERGENCE: THE NESTE CASE

Master's Thesis
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Abstract

Changes in organizations and in the operating environment occur on a regular basis. In the context of organizational routines, this indicates that routines will remain, change, emerge or be unlearned. Yet, routine emergence and managerial role in routines lacks previous academic research. Managing routine emergence is a somewhat contrasting concept, which offers an interesting starting point to examine the topic.

The purpose of this study is to be describe routine emergence and the managerial role in routines. The study aims to shed light on understanding the phases of routine emergence, factors affecting the emergence as well managerial role in the process and the way to verify competence in routines. To achieve this, the study adopts a practice-based view of routines.

The research builds on critical realism approach. The empirical part of the research was conducted as a case study with three embedded cases of investment projects in which the emergence of new operating routines was examined. The case company was Neste, a Finnish company that operates on a global market in three business areas: oil products, renewable products, and marketing & services. Sources of data collection consisted of participant observation, 15 semi-structured interviews, and documentation.

The study reveals that routine emergence consists of three main phases: routine content definition, routine learning, and routine implementation in practice. The findings indicate that routine emergence cannot be fully planned since unexpected issues take place during the routine implementation. The study highlights the importance of operator involvement in each phase of the routine emergence. "Building your own house" was seen as descriptive representation for operator involvement in projects. Interestingly, operators acquire a comprehensive understanding of the process during the project work, but still a considerable part of learning takes place during and after the routine implementation. During this period, attentiveness, ability to understand how the process works against the guidelines and planned routines, readiness to surprises, and flexibility in operations are needed. Moreover, the study shows that it is critical to verify competence in routines.

This study thereby has two theoretical contributions: new routine emergence and the managerial role in routines. The research provides with four practical implications for managers: 1) managing routine emergence is essential, 2) routine content definition extends beyond a specific routine, 3) well-planned trainings enable and enhance routine learning, and 4) routine implementation implies changes to the planned routine.

Keywords organizational routines, routine emergence, managerial role, mindfulness

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Tiivistelmä

Organisaatioissa ja toimintaympäristössä tapahtuu muutoksia säännöllisesti. Organisaation rutiineiden kontekstissa tämä merkitsee sitä, että rutiinit säilyvät, muuttuvat, kehkeytyvät tai niistä poisopitaan. Kuitenkin rutiinien kehkeytymistä ja johdon roolia rutiineissa ei ole aiemmin tutkittu akateemisesti. Kehkeytyvän rutiinin johtaminen on jokseenkin vastakohtainen konsepti, mikä tarjoaa kiinnostavan lähtökohdan tarkastella aihetta.

Tämän tutkimuksen tavoitteena on kuvata rutiinin kehkeytyminen ja johdon rooli rutiineissa. Tutkimuksen tarkoituksena on valottaa rutiinin kehkeytymisen prosessia, kehkeytymiseen vaikuttavia tekijöitä sekä johdon roolia prosessissa ja tapaa varmentaa osaaminen rutiineissa. Jotta tämä saavutetaan, tutkimuksessa käytetään käytäntöpohjaista näkökulmaa rutiineihin.

Tutkimus rakentuu kriittisen realismin lähestymistapaan. Empiirinen osuus tutkimuksesta toteutettiin tapaustutkimuksena, joka sisälsi kolme sulautettua tapausta investointihankkeista, joissa tarkasteltiin uusien operointirutiinien kehkeytymistä. Tapausyrityksenä toimi Neste, suomalainen yritys, jolla on liiketoimintaa globaalisti kolmella eri alueella: öljytuotteet, uusiutuvat tuotteet ja markkinointi & palvelut. Tiedonkeruulähteet muodostivat osallistuva havainnointi, 15 puolistrukturoitua haastattelua ja dokumentointi.

Tutkimus osoittaa, että rutiinin muodostuminen koostuu kolmesta päävaiheesta: rutiinin sisällönmäärittely, rutiinin oppiminen ja rutiinin toteutus käytännössä. Tulokset osoittavat, että rutiinin kehkeytymistä ei voi täysin suunnitella, sillä odottamattomia asioita tapahtuu rutiinin toteutuksen aikana. Tutkimus korostaa operaattoreiden osallistumisen tärkeyttä jokaisessa rutiinin kehkeytymisen vaiheessa. ”Oman talon rakentaminen” nähtiin kuvailevana representaationa operaattoreiden projektiin osallistumiselle. Kiinnostavana havaintona nousi esille, että operaattorit muodostavat syvällisen ymmärryksen prosessista projektityön aikana, mutta silti huomattava osa oppimisesta tapahtuu rutiinin toteutuksen aikana ja sen jälkeen. Tämän ajanjakson aikana tarkkaavaisuus, kyky ymmärtää prosessin toiminta ohjeita ja suunniteltuja rutiineja peilaten sekä valmius yllätyksiin ja joustavuus operoinneissa ovat tarpeen. Lisäksi tutkimus osoittaa, että on kriittistä varmentaa osaaminen rutiineissa.

Tällä tutkimuksella on täten kaksi teoreettista kontribuutiota: uuden rutiinin kehkeytyminen ja johdon rooli rutiineissa. Tutkimus tarjoaa neljä käytännön sovellusta johdolle: 1) rutiinin kehkeytymisen johtaminen on välttämätöntä, 2) rutiinin sisällönmäärittely ulottuu laajemmalle kuin yksittäinen rutiini, 3) hyvin suunnitellut koulutukset mahdollistavat ja edistävät rutiinin oppimista ja 4) rutiinin toteutus merkitsee muutoksia suunniteltuun rutiiniin.

Avainsanat organisaation rutiinit, rutiinin kehkeytyminen, johdon rooli, tietoinen läsnäolo

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Helsinki, May 2017

Sanna Unkuri

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Abbreviations

NCON = Naantali Configuration
Operator = Process operator (blue-collar worker) at refinery
PL = Production Line
SDA = Solvent Deasphalting Unit
Unit = Process Unit at refinery
VRU = Vapor Recovery Unit

1 Introduction

A process operator conducts a field tour at a production line and examines a process unit. The operator knows how the process works, and has the ability to notice abnormal situations. Suddenly, the operator comes across something extraordinary and contacts the panel operator using radiophone in order to get more information of the observation he/she came across in the field. Both the field operator and panel operator do the needed adjustments to the process in cooperation, and manage to prevent a possible production disruption.

Process operators enact multiple operating routines daily. While working e.g. at a production line or harbor they become familiar with the operations and get a deep understanding of different processes. However, "disruption is the new norm: the rate of change is so high everywhere these days that you now must *assume* that someone will disrupt you, and often from a direction you least expect" (Ismail et al., 2014, p. 124). In the context of organizational routines, this indicates that routines will remain, change, emerge or be unlearned.

Change projects in production at Neste, a Finnish company that produces a comprehensive range of major petroleum products, lead to new operating routines. How would the new routines emerge when nothing concrete exists? Neste wanted to develop the way to manage routine emergence due to the importance of being competent in operations. How could they manage the process? What should they do in order to verify competence in the routines?

Managing routine emergence is a somewhat contrasting concept, which offers an interesting starting point to approach the topic.

Organizational routines are defined as repetitive patterns of interdependent organizational action (Feldman and Pentland, 2003). Traditionally routines have been viewed to promote stability and reliability in organizations (Nelson and Winter, 1982). Over the last decade, the practice-based perspective on organizational routines has taken root (Feldman and Orlikowski, 2011). The perspective highlights the patterns of action within routines and examines them as generative systems with internal dynamics: ostensive and performative aspects (Feldman, 2000). Thus, routines are seen as action that can produce both stability and change (Feldman, 2000; Feldman and Pentland, 2003).

Moreover, routine enactment requires mindfulness (Levinthal and Rerup, 2006) and is mutually constitutive with organizational structure (Parmigiani and Howard-Grenville, 2011). Consequently, e.g. actors, agency, and artifacts are themes that are getting more attention at the routine research: especially the influence of organizational structure, including artifacts, for the enactment of routines (Parmigiani and Howard-Grenville, 2011).

In addition, routine changes and performance variety have been studied. New technology implementation has been shown to require a collective learning process in which implementation leader had a critical role (Edmonson et al., 2001). Undesired interruptions (Danner-Schröder, 2016), learning, improving or changing a routine may lead to performance variation (e.g. Edmonson et al., 2001; Feldman, 2000). However, little focus has been given to emergence of new routines and to the managerial role in routines in the previous research.

The two topics are identified as research gaps and my study was conducted in order to start filling these gaps. Thus, the aim of this thesis is to explore routine emergence and the role of management in routines. The research question and sub-questions of this study are the following:

RQ: How do routines emerge in the refining industry and how the emergence is managed?

a. What phases can be recognized in the routine emergence?
b. What factors affect the routine emergence?
c. What is the managerial role in the process?
d. How to verify competence in routines?

The first sub-question aims to form a general view of the different phases included in the routine emergence. The second sub-question aims to discover different factors that affect the process of routine emergence. The third sub-question directs focus especially to the managerial role in new routine emergence. The fourth sub-question examines competence in routines and how the competence can be verified.

I address my research question through a single case study with three embedded cases at case company Neste: Naantali configuration (NCON) project, solvent deasphalting unit (SDA) project, and vapor recovery unit (VRU) project. The cases are change projects to increase profitability or meet environmental regulations at the Porvoo and Naantali refineries. I studied operating routines that emerge in the cases.

The study reveals that routine emergence consists of three main phases: routine content definition, routine learning, and routine implementation in practice. Routine implementation in practice was the most challenging one to manage. My findings indicate the importance of a flexible approach during the routine implementation when e.g. start-up of a process unit takes place. Operator involvement starting from the beginning of the project work seems to be critical in routine emergence. "Building your own house" was seen as descriptive representation for operator involvement.

Interestingly, operators acquire a comprehensive understanding of the process during the project work, but still a considerable part of learning takes place during and a few months after the unit start-up when everything is concrete. Moreover, the study indicates the importance of verifying competence before, during and after the unit start-up in routine emergence. Especially knowledge sharing within and between shifts, guiding but not restricting guidelines, and well-planned training methods, including common discussions about the changes, were seen to enhance competence in routines.

This study thereby has two theoretical contributions: new routine emergence and the managerial role in routines. Routine emergence can be planned to some extent: modifications to the planned routines take place during the routine emergence since unexpected issues occur during the process. The research provides with four practical implications for managers: 1) managing routine emergence is essential, 2) routine content definition extends beyond a specific routine, 3) well-planned trainings enable and enhance routine learning, and 4) routine implementation implies changes to the planned routine.

The remainder of the paper is structured as follows. First, I review the research conducted in the field of organizational routines. Second, I introduce the research design and methods by describing the research approach, introduce the case company as well as competence management and investment projects that take place at the company. I also describe main actors in the investment projects and the three embedded cases. Then, I outline the data collection and analysis process, including methods of participant observation, interviews and documentation. Third, I present the findings by describing the cases, and examining routine content definition, routine learning, and routine implementation in practice as well as managerial role in the routine emergence in the studied cases. Fourth, I analyze the findings in relation to the theory and highlight the contribution to the routine research.

2 Literature review

In this chapter, I review the concept of routines and empirical studies conducted in the field of organizational routines. First, I examine how organizational routines have been studied in the previous research, and focus on the practice-based perspective on routines. The perspective highlights the patterns of action within routines, and examines the internal dynamics: ostensive and performative aspects (Feldman, 2000). Consequently, e.g. actors and agency, artifacts and embeddedness are themes that are getting more attention at the routine research.

Then, I describe the role of mindfulness (Langer, 1989) and routines in high-reliability organizations (HROs). The current research does not see routines as stable patterns of action (Nelson and Winter, 1982), but as changing action that requires mindfulness (Levinthal and Rerup, 2006) and is mutually constitutive with organizational structure (Parmigiani and Howard-Grenville, 2011). Accordingly, I finally examine the role of artifacts in routine performance, routine development, and performance variations.

2.1 Organizational routines

2.1.1 Organizational routines in general

Organizational routines are defined as repetitive patterns of interdependent organizational actions (Feldman and Pentland, 2003) that help to cope with complexity (Nelson and Winter, 1982). Routines have multiple effects on organizations; such as they coordinate and control, reduce uncertainty, bring along stability, and store knowledge (Becker (2004). Nelson and Winter (1982) were not the first ones to study routines but their contributions for understanding

organizational and economic change through routines fostered research interest toward the concept of routines (Becker, 2004). Nelson and Winter's book "An Evolutionary Theory of Economic Change" (1982) "put the concept of routines center-stage, drawing both attention to the role of routines in the economy, and the role of the concept of routines in theory" (Becker, 2004, p. 643).

Similarly, Parmigiani and Howard-Grenville (2011, pp. 415-16) emphasize the significance of Nelson and Winter's (1982) work, and bring up their idea of categorizing routines. Routines are categorized "as those that are related to knowing how to do (e.g. production or implementation) versus those that are related to knowing how to choose (e.g. deliberation, alternative selection, or modification), whereas capabilities are defined as the range of things a firm can do at any time" (Nelson and Winter, 1982, p. 52). Concluding, Nelson and Winter (1982) "expanded the idea of routines beyond relatively simple procedures or programs" (Parmigiani and Howard-Grenville, 2011, p. 415-416).

Becker (2004) emphasizes two aspects: what routines are, and what effect they have on organizations. Becker (2004) brings up two main interpretations the term "routines" has: behavioral regularities and cognitive regularities. In the former routines are defined as recurrent interaction patterns, whereas in the latter routines are seen as e.g. rules and standard operating procedures. In other words, they take place on two different levels: cognition and activity. (Becker, 2004).

Becker (2004) examines the nature of routines by identifying routine characteristics that are listed in table 1 based on literature view on routines. Becker (2004) brings up characteristics

such as patterns, recurrence and collective nature of routines, which implies that multiple actors are part of the process that is linked by interaction. In addition, knowledge is dispersed, which leads to uncertainty since actors are not aware of all the possibilities. Thus, for organizational coordination it is essential to balance individual habits and organizational routines. Routines are also context-depended, situated, and guided by action-related triggers. (Becker, 2004).

Table 1 Routine characteristics, based on Becker (2004)

Characteristic of routines
Patterns
Recurrence
Collective nature of routines
Mindlessness vs. effortful accomplishment
The processual nature of routines
Context-dependence, embeddedness and specificity
Path dependence (feedback effects)
Triggers (action related triggers and external cues)

Organizational routines have been studied through the lens of capabilities and the lens of practice. The former approach has its roots in organizational economics, and the latter in organization theory. Scholars from the capabilities perspective are mainly interested in studying the purpose or motivation for routines and their impact on firm performance whereas scholars from the practice perspective highlight the practice of routines, how they work, and their internal dynamics. (Parmigiani and Howard-Grenville, 2011).

In their literature review, Parmigiani and Howard-Grenville (2011) summarize the capabilities and practice approaches, and identify common themes by analyzing recent empirical studies. Empirical studies conducted in the field and key findings of capabilities and practice perspective are summarized in table 2. Contrasting to the capabilities perspective, the practice perspective highlights the importance of everyday actions in routine generation, performance, change and stability. In addition, the practice perspective emphasizes the salient role of actor in routine performance, the internal dynamics of routine reproduction, and sees that "routines are mutually constituted with other structures". (Parmigiani and Howard-Grenville, 2011, p. 440).

Moreover, Parmigiani and Howard-Grenville (2011) state that the capabilities and practice perspectives can be complementary regarding some elements, thus contribute to the discussion by forming a more comprehensive view of organizational routines. They identify the following three themes that are common for the two perspectives: individuals matter, tacitness matters, and routines are both stable and changing.

Table 2 Summary on empirical studies conducted in the capabilities and practice perspective, based on Parmigiani and Howard-Grenville (2011)

	Capabilities perspective	**Practice perspective**
Methods	Case studies, surveys, archival panels	Direct observation along with other data collections methods (interviews, archival documents)
Contexts	Wide range, e.g. manufacturing and service, relatively high and more basic technology, professional sports	E.g. manufacturing, equipment supplier, university housing offices
Main themes	Microfoundations of capabilities Routines as genes Routines as the basis of learning	Actors and agency Artifacts Embeddedness
Key findings	1. Firm specificity of routines and their influence on performance. 2. Routines as underlying components of capabilities. 3. Routines are sticky within the organization, affected by broader organizational characteristics (e.g. structure), and rather difficult to change. 4. Routines as a basis for organizational change through learning. 5. Routines can affect firm boundary decisions.	1. Everyday actions are consequential for the generation, performance and change or stability of routines. 2. Importance of who performs a routine to how routine is enacted. 3. Internal dynamics: routines are mutually constituted with other structures (e.g. culture, patterns of coordination or relationships between groups, rules or artifacts). This context shapes the use of routines, as well as whether and how they change over time.

Next, I examine more closely routine dynamics that is one of the key findings in the field of practice-based research on organizational routines.

2.1.2 Routine dynamics

The traditional approach sees that organizational routines promote stability, reliability and efficiency that lead to efficient accomplishment of recurring tasks (Nelson and Winter, 1982). However, over the last decade practice-based understanding that emphasizes the actual performances instead of standard operating procedures has taken roots (Howard-Grenville, 2005). The perspective started to develop when Feldman (2000) brought up a finding that views routines as a source of continuous change. Thus, recent research sees that routines are not only "actions that connect stimuli and responses, but ongoing, situated accomplishments" (Howard-Grenville, 2005, p. 635).

Feldman (2000) introduced the concepts of ostensive (routine in principle) and performative (routine in practice) aspects. Based on these concepts, Feldman and Orlikowski (2011) define routines as "generative systems created through the mutually constitutive and recursive interaction between the action people take (performative aspect of routines) and the pattern these actions create and recreate (ostensive aspects of routines)" (p.1245).

Feldman and Orlikowski (2011) noted that there are multiple ostensive aspects, which indicates that depending on the point of view, different actors may have different understandings of the routine. Moreover, the performative and observable aspect of the routine may vary. Turner and Rindova (2012) contributed to the discussion by showing that the different roles that actors have within a routine may affect perceptions of what is included in the routine, as happened in their case of waste collection routine performance.

Routines as practices approach sees that "the development of the routine occurs through the enactment of it" (Feldman and Orlikowski, 2011, p. 1245). Accordingly, the practice-based view highlights the importance of human agency that is configured by structural conditions, in the enactment of routines (Feldman and Orlikowski, 2011). Thus, e.g. material aspects (artifacts) of routines are part of the routine enactment (Feldman and Pentland, 2003).

Routine performances have an effect on the ostensive routine aspects since they create, modify, and maintain them (Feldman and Orlikowski, 2011). Thus, routines are not stable but generative systems that can produce both stability and change based on the routine dynamics (Feldman, 2000; Feldman and Pentland, 2003). Feldman et al. (2016) bring up three key observations related to routine dynamics that are presented in figure 1: 1) action in routines is situated, 2) actors are knowledgeable and often reflective, and 3) routines are stable for now.

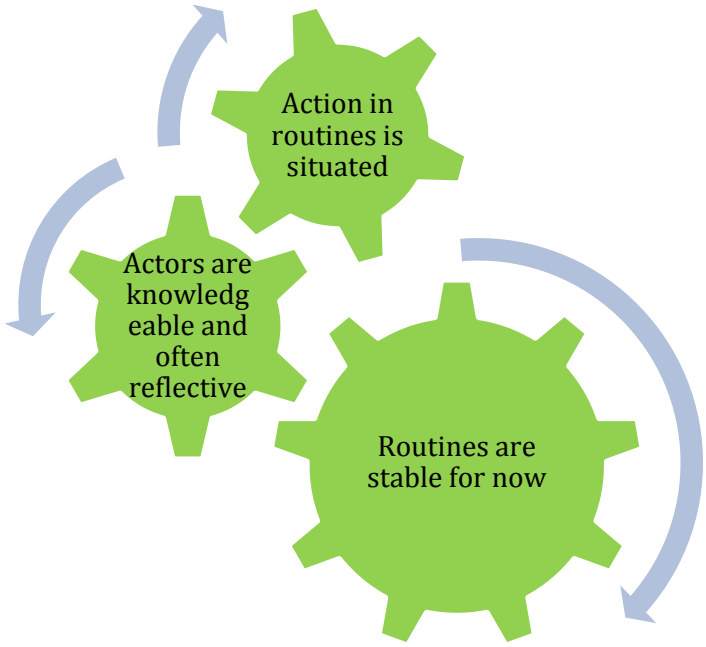

Figure 1 Three core observations intrinsic to the work in routine dynamics, based on Feldman et al. (2016)

Similarly, Pentland and Feldman (2008) state that change is part of the routine process indicating that unintended patterns may arise. Thus, it is important to observe and pay attention to the routine in order to discover if action is needed to keep the routine on track, or if there are multiple appropriate patterns or sets of actions (Pentland and Feldman, 2008).

The above discussed core observations in the field of routine dynamics indicate that knowledgeable and reflective approach are needed in the routine enactment. Accordingly, I examine the role of mindfulness in routines.

2.1.3 Mindfulness in the enactment of routines

Ellen Langer's (1989) concept of mindfulness (as cited in Sternberg, 2000) has its roots in the psychology literature. Langer's definition of mindfulness (as cited in Sternberg, 2000, p. 13) includes "components of (a) openness to novelty; (b) alertness to distinction; (c) sensitivity to different contexts; (d) implicit, if not explicit, awareness of multiple perspectives; and (e) orientation in the present, whereas 'mindlessness' is the lack of these attributes". Similarly, Pentland and Rueter (1994) brought up notions of routines as effortful accomplishments that are enacted by reflective organizational members. Levinthal and Rerup (2006) support these aspects by highlighting two requirements for mindfulness: 1) "attentiveness to one's context and 2) the capacity to respond to unanticipated cues or signals from one's context" (p. 504).

While there exists a growing body of literature covering the notion of mindfulness, research on the role of routine-driven, or less-mindful, behavior has a long tradition in the organization literature (Levinthal and Rerup, 2006). Levinthal and Rerup (2006) bring up complementarity between these two perspectives: they are not distinctive categories but there are

interrelationships, including processes of acting and thinking, between the mindful and less-mindful behavior. Since routines are not fixed (Feldman, 2000), and performative activity (actual behavior) requires enactment of the individual's ostensive (cognitive) understanding of the process (Feldman and Pentland, 2003) also routinized behavior has its basis in the elements of mindfulness (Levinthal and Rerup, 2006).

Thus, mindfulness can be seen as an effortful accomplishment in a given context. Repertories of action, including a set of routines to choose from and recombine, enable mindfulness in action and a rapid response to stimuli. However, the context of novel situations sets challenges and requires special effort and mindfulness in finding appropriate routines. (Levinthal and Rerup, 2006). Next, I examine routines and role of mindfulness in a special context that is high-reliability organizations.

2.1.4 Routines in high-reliability organizations

Weick and Sutcliffe (2007) support the importance of mindfulness in their studies of high-reliability organizations (HROs). HROs take place in settings where extreme potential for error and disaster exists: examples include aircraft operations systems, emergency medical treatment teams, nuclear power generation plants, and continuous processing firms. These reliability-dependent organizations have developed ways of acting and styles of learning to manage the unexpected. Consequently, they have an ability to perform mindfully in unforeseen and unanticipated events: to excel in operations despite repeated interruptions. (Weick and Sutcliffe, 2007, pp. 9-10).

Trial-and-error learning, where error indicates system failure, is not an option in HRO settings. Thus, mindfulness enables "the potential for attending to more subtle cues and feedback that emerge from ongoing operations as a basis for effective adaptation in such circumstances". (Levinthal and Rerup, 2006, pp. 508-509). Accordingly, routines are constantly modified and adjusted in a dynamic manner (Feldman 2000; Feldman 2003).

Expectations are implicit assumptions that direct attention, and all deliberate actions are based on assumptions (Weick and Sutcliffe, 2007, pp. 23-27). Weick and Sutcliffe (2007, pp. 23-27) enhance the need to first understand expectations (how they work), and then the way to engage them mindfully. Typically, expectations have their roots in organizational roles, routines, and strategies, and to expect is to envision something, such as the probable course of events (Weick and Sutcliffe, 2007, pp. 23-27).

Weick and Sutcliffe (2007, pp. 25-27) bring up people's problematic tendency to actively search confirmation to their expectations, which is partly based on experiences and their consequences. What is notable is that people search confirmation in the form of routines and plans. The trap is that disconfirming evidence is largely avoided, and confirmation is based on fewer and fewer data. Because of the biased search blind spots get larger, in other words, small errors get bigger. In addition, automatic behavior may take place: familiar routines are put into action even in situations where they are not appropriate (Levinthal and Rerup, 2006). What is needed here are "continuing efforts to update the routines and expectations and to act in ways that would compel such updating" (Weick and Sutcliffe, 2007, p. 27). HROs understand that

expectations are incomplete, doubt the most confirmed expectations, and remain alert. (Weick and Sutcliffe, 2007, pp. 25-27).

Unexpected events can be divided into three categories: an event that was expected to happen fails to occur, an event that was not expected to happen does happen, and an event that was simply unthought of happens. All these events start with expectations, and HROs are strongly aiming to increase the understanding of the third form of the unexpected that was unthought. They want to discover all the imaginable events, and imagination is encouraged in the form of mindful practices. Mindful practices "foster enriched expectations, increase the ability to make novel sense of small interruptions in expectations, and facilitate learning that intensifies and deepens alertness". (Weick and Sutcliffe, 2007, pp. 27-30).

Weick and Sutcliffe (2007) present five defining principles of high-reliability organizations: 1) practices are preoccupied with failure, 2) reluctance to simplify details, 3) sensitivity to operations, 4) commitment to resilience, and 5) deference to expertise not experts. These processes enhance mindfulness in organizations. Accordingly, HROs have the ability to perform mindfully in unforeseen and unanticipated events: to excel in operations despite repeated interruptions (Weick and Sutcliffe, 2007). The five principles are presented also in the work of Weick et al. (2008) in the form of figure 2.

Figure 2 A mindful infrastructure for high reliability, Weick et al. (2008)

The first three principles emphasize anticipation (prevention of the unexpected event itself) whereas the last two are principles of containment (prevention of unwanted outcomes after an unexpected event has occurred). The principles and related practices that Weick and Sutcliffe (2007) bring up are summarized in table 3.

The first principle, practices are preoccupied with failure, indicates that HROs monitor and examine each small failure to correct and learn from them earlier in order to find out a possible failure in the interconnected system. The second principle, reluctance to simplify details, implies that HROs do not either simplify things too much or put them into general categories, and use hands-on observation since all the details are found meaningful. The third principle, sensitivity to operations, means that HROs also use interpretative practices, pay attention to situations and learn from "close calls" to put into practice meaningful actions in a specific context. (Weick and Sutcliffe, 2007, pp. 43-64).

However, Weick and Sutcliffe (2007) emphasize that plans cannot be made for everything. Plans can even create mindlessness to some extent since they set expectations, and guide attention to things that seem to be worth noticing. Planning of contingent actions also precludes improvisation. Moreover, in novel situations people cannot rely on routines, patterns of activity that have worked in the past. (Weick and Sutcliffe, 2007, pp. 65-68).

Extensive rules and procedures that indicate lost flexibility can also cause problems. Weick and Sutcliffe (2007) bring up an example of maintenance workers who could not complete an assigned task in a nuclear plant since they could not find a procedure that covered the specific situation. The issue is that all the possible situations cannot be covered and anticipated in written procedures since conditions vary (Weick and Sutcliffe, 2007, pp. 65-68).

In the management of unexpected, the importance of mindful reacting is highlighted: "reliable outcomes require the capabilities to sense the unexpected in a stable manner and yet deal with the unexpected in a variable manner" (Weick and Sutcliffe, 2007, p. 67). The fourth principle, commitment to resilience, requires mindfulness about errors that have already taken place, learning from the error, and implementation of that learning into practice. (Weick and Sutcliffe, 2007, pp. 65-68).

The fifth principle, deference to expertise not experts, includes the idea that expertise, emphasized at HROs, is not just content knowledge, but also credibility, trust and attentiveness (Weick and Sutcliffe, pp. 65-68). Accordingly, relationships are emphasized: "expertise relies as much in relationships as in individuals, meaning that interrelationships, interactions, conversations, and networks embody it" (p. 82).

Table 3 Acting with anticipation and containment: five principles of high-reliability organizations (HROs), based on Weick and Sutcliffe (2007)

Principle	**Description**	**Examples of related practices**
1. Practices are pre occupied with failure.	Each small failure is monitored and examined to correct and learn from them earlier in order to find out a possible failure in the system.	All organizational members are persuaded to be chronically concerned about the unexpected. A climate is created where people feel safe to question assumptions or to report problems or failures candidly. People are helped to expand the number of undesired consequences they envision.
2. Reluctance to simplify details	Things are not simplified too much or put into general categories.	A climate is created where people are wary of success, suspicious of quiet periods, as well as concerned about stability, routinization, and lack of challenge and variety that can lead to carelessness and error. Tendencies to simplify assumptions, expectations, and analyses are counteracted through e.g. frequent job rotations and retraining.
3. Sensitivity to operations.	Interpretative practices are used, attention is paid to actual situations and "close calls" are seen as learning opportunities.	Members are encouraged to view close calls as a kind of failure that reveals potential danger, rather than as evidence of success and the ability to avoid disaster. A climate is created that encourages variety in people's analyses of the organization's technology and production processes.
4. Commitment to resilience.	HROs are adapted to changing circumstances: they deal with the unexpected in a variable manner, but sense the unexpected in a stable manner.	As much attention is paid to building capabilities to cope with errors as to improving capabilities to plan and anticipate events before they occur. Capabilities are developed for mindfulness, swift learning, flexible role structures, and quick size-ups (opinions about a situation).
5. Deference to expertise not experts.	Expertise is seen to include not just content knowledge but also credibility, trust and attentiveness.	A set of operating dynamics, that shift leadership to the people who currently seem more likely to have an answer to the problem at hand, is created.

As the above-discussed example of maintenance workers who could not find suitable procedure revealed, artifacts might restrict routine performance. Next, I outline the role of artifacts in routine performance.

2.1.5 Role of artifacts in routine performance

Already in the early stages Nelson and Winter (1982) noted that "skills, organization, and technology are intimately intertwined in a functioning routine" (p.104), indicating that artifacts are part of the routine replication (Nelson and Winter, 1982). Parmigiani and Howard-Grenville (2013, p. 438) summarize that early research on the role of artifacts on routine performance has examined artifacts as "either representations (e.g. rules or standard operating procedures) or material entities (e.g. computers, physical spaces)".

The influence of organizational structure, including artifacts, for the enactment of routines has started to gain increased attention within the practice perspective on routines (Parmigiani and Howard-Grenville, 2011). It is stated, "Arrangements await interpretation, while routines are rules already interpreted", which suggests a mutually constitutive relationship between artifacts and actors (Reynaud, 2005, p. 866, cited in Parmigiani and Howard-Grenville, 2011). Parmigiani and Howard-Grenville (2011), who outlined empirical research on routines, and noticed, "Artifacts do not necessarily act as expected in encoding or cueing routines" support this (p.438).

Artifacts, e.g. in the form of guidelines and technology, may enable, guide or restrict the routine enactment. Howard-Grenville (2005) examined the role of agency in shaping routine

performances by observing a high-tech manufacturer. Routines are defined in the study as situated actions that are performed by multiple actors who may have different expectations and orientations towards the routine performance (Howard-Grenville, 2005). Thus, routines are shaped by agency since actors may "intentionally or unintentionally recreate these patterns" by selecting how to perform the selected aspects of a routine at a given time (Howard-Grenville, 2005, p. 618).

Besides actors, also context, including technological, coordination and cultural structures, may shape the routine performance. Howard-Grenville (2005) noticed that routines are enacted simultaneously with the structures that "generate overlapping artifacts and social expectations" (p. 631). If the routine is strongly embedded, implying that the routine overlaps with many structures, the overlap is significant and reinforces artifacts and expectations, the routine may be performed in a flexible way in a situation at hand but changes in routine over time are unlikely. Thus, organizational context may constrain the ongoing adaptation of a routine. (Howard-Grenville, 2005).

Danner-Schröder and Geiger (2016) found out that codification of guidelines was different depending on the perceived stability or flexibility of the routine. In routines that were perceived as stable, artifact codifying the workflow was used, whereas in flexible routines artifact codifying the task was used. Thus, in the case of flexible routines the aim was to describe the task in principle, not to specify a detailed process description, in order to enable adaptation to different situations. (Danner-Schröder and Geiger, 2016).

Moreover, the practice perspective has fostered research in the field of technology-in-practice (Orlikowski, 2000) besides technological artifacts (Feldman and Orlikowski, 2011). The role of human agency in the use of technology at work, especially the potential to adapt technology, has attracted increased attention. Feldman and Orlikowski (2011) noted, "Technology only becomes valuable when people actually engage with it in practice" (p. 1246). Accordingly, the successful use of technology depends on, how the technology is actually used in practice in specific situations.

Pentland and Feldman (2008) who note that designing routines is not just designing artifacts, but requires much more effort in order to develop a functioning routine support this view. This notion is based on the earlier discussion stating that routines are enabled by patterns of interdependent action that are carried out by multiple participants, and are generative systems by nature (Pentland, 2000). Accordingly, Pentland and Feldman (2008) state that training, including practicing together, feedback on collective performance, and some more practicing together is critical if interdependent action takes place. Moreover, Pentland and Feldman (2008) argue that managers plan the artifacts, but highlight the importance of empowering routine participants in the actual routine performance so that the "users become designers" (p. 248).

2.1.6 Routine development and performance variations

Edmonson et al. (2001) examined routine development in a hospital setting where a new technology for cardiac surgery was implemented. The technology required significant changes in the operating room teamwork practices, e.g. surgeon's role shifted from being a leader to

being a team member, and high involvement of a multidisciplinary team (Edmonson et al., 2001).

Edmonson et al. (2001) found out that specific learning practices, which are presented in figure 3, supported the adoption of a new routine in teams, whereas other prevented successful implementation. The successful implementers went through a qualitatively different team learning process in which implementation leaders had a critical role (Edmonson et al., 2001). Thus, routine change occurred through a team learning process. The iterative learning cycle that lead to successful implementation includes four phases: "(1) carefully select a team, (2) practice and communicate, (3) work to encourage communication while experimenting with new behaviors in trials, and (4) take time to reflect collectively on how trials are going so that appropriate changes can be made" (Edmonson et al., 2001, p. 710).

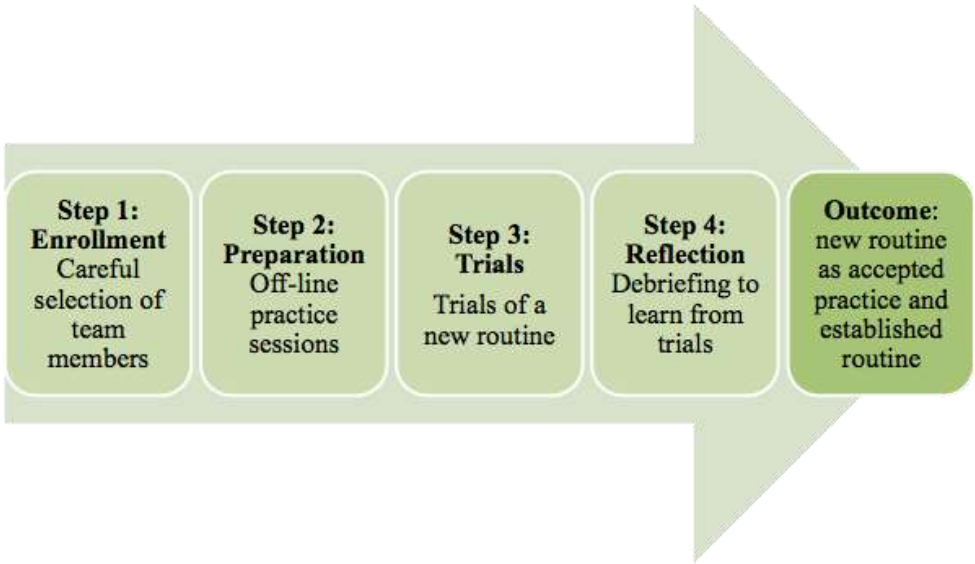

Figure 3 A process model for establishing new technological routines, Edmonson et al. (2001)

Moreover, Edmonson et al. (2001) highlight the importance of team empowerment, interpersonal learning and team learning in routine implementation. In successful cases the leaders were committed to the deployment of emerging routine, framed the technology as a fundamental change instead of a plug-in technology, communicated with the team and enhanced psychological safety within the team. Thus, active learning process management by local leaders is needed in the new team routine development. (Edmonson et al., 2001). The above-discussed constructs that enhanced technology implementation process are presented in figure 4 below.

Figure 4 Relationships between constructs in the technology implementation process, Edmonson et al. (2001)

Danner-Schröder and Geiger (2016) examined through an ethnographic case how a catastrophe organization enacts routines. They observed three routines: setup of base of operation, triage and marking, and search and rescue, which all occur in highly dynamic settings. Danner-Schröder and Geiger (2016) found out that routines were carried out differently based on perceptions of stability and flexibility. Routines that were seen as stable were enacted through

aligning and prioritizing, whereas flexible routines were enacted through selecting and recombining (Danner-Schröder and Geiger, 2016).

In addition, Danner-Schröder and Geiger (2016) discovered that artifacts, training, and knowing are at the core of enacting and maintaining patterns, and have different roles in enhancing patterns of standardization of flexibility. Content of the training varied depending on the following three principles: to enhance patterns of standardization or flexibility or to create cross-member expertise and build a team. The role of training in routines is presented in table 4 below.

Table 4 The role of training in enhancing patterns of standardization or flexibility, Danner-Schröder and Geiger (2016)

Second-order theme	**First-order theme**
The role of training in enhancing patterns of **standardization**	• Learning how to enact the workflow • Learning how to prioritize actions
The role of training in enhancing patterns of **flexibility**	• Learning how to enact the tasks • Learning how to select and recombine actions
Creating **cross-member expertise and building a team**	• Learning through narratives • Learning from experience • Identifying as a team

Routine development and routine performance variations can also be based on interruptions. Unexpected events, such as disruptions, are mainly studied in the context of high-reliability

organizations in which unexpected situations are expected (Weick and Sutcliffe, 2007), and integrated into a stable routine understanding despite deviations in the routine performance (Danner-Schröder, 2016).

Danner-Schröder (2016) composed the different ways to conceptualize routine interruptions (p. 68). First, traditional view sees interruptions as disruptive events, implying that "routines are viewed as stable entities without interruptions" (e.g. Nelson and Winter, 1982). Second, group and team literature approach as well as crisis management research sees interruptions as chance to change routines since "routines can change after an interruption". Third, routines as practice perspective has revealed that routines "can change due to internal dynamics" (e.g. Edmonson et al., 2001). Fourth, previous research on unexpected events sees routines "as flexible perfomance" (e.g. Weick and Sutcliffe, 2007). (Danner-Schröder, 2016, p. 68).

Danner-Schröder (2016) examined how routine recognizability is created despite performance interruptions and multiple ostensives by focusing on micro processes of routines. In her study, Danner-Schröder (2016) analyzed pumping routines as joint performances in catastrophe management organizations on an ethnographic field study. Contrasting to the previous research on high-reliability organizations (e.g. Weick and Sutcliffe) that identifies interruptions as isolated events, Danner-Schröder (2016) came across that routine interruptions took place due to different subjective understandings by the actors, which lead to performance variety. For example, in the case of pumping routine squad leaders did not get the support they expected since the team leader expected them to know how to operate in the given situation. Instead of giving squad leaders a complete task of setting up a pump, the team leader started to instruct

them about details. This lead to a situation in which squad leaders did not take responsibility but “just started doing something instead of thinking about it first and waiting for further instructions” since the team leader gave an impression that an assessment of the situation was not needed. Accordingly, squad leaders neither “saw the complete picture” nor organized the task by themselves. (Danner-Schröder, 2016, p. 80).

In order to repair the interruption, before continuing the core routine pattern, different modes of communication were used in the study. During the routine performance, a narrative mode took place, whereas when actors stopped performing the core routine they switched to an argumentative mode, and started to discuss the problem and actively search for a problem-solving alternative (Danner-Schröder, 2016).

Danner-Schröder’s (2016) findings refine the idea of routines as effortful accomplishments being more than “just choosing among a constrained set of possibilities” (p. 93). Instead, actors searched for “alternative solutions to a problem, which are not in any sense pre-defined” (p. 93). In addition, central to the performance continuation was cooperation within the workers in the given situation. (Danner-Schröder, 2016). Thus, undesired interruptions are one way to understand performance variation besides learning, improving or changing a routine (e.g. Edmonson et al, 2001; Feldman 2000). (Danner-Schröder, 2016).

2.2 Summary of the literature review

Feldman and Pentland (2003) define organizational routines as repetitive patterns of interdependent organizational action. Traditionally routines have been viewed to promote stability and reliability in organizations (Nelson and Winter, 1982), but the practice-based view on routines sees routines as generative systems that promote both change and stability (Feldman, 2000; Feldman and Pentland, 2003). The main streams of research in the literature review come from four different fields: routine dynamics, role of artifacts in routine performance as well as routine development and performance variations.

Organizational structures, such as culture and artifacts, are mutually constitutive with organizational routines (Reynaud, 2005), and artifacts enable, guide or restrict the routine enactment. Moreover, artifacts, training, and knowing are at the core of enacting and maintaining patterns of standardization and flexibility (Danner-Schröder and Geiger, 2016). New technology implementation has been shown to require a collective learning process in which implementation leader has a critical role in framing the change as a fundamental change instead of a plug-in technology (Edmonson et al., 2001).

In addition, routines have been studied through a mindfulness lens (Levinthal and Rerup, 2006), and in the special context of high-reliability organizations (Weick and Sutcliffe, 2007; Weick et al., 2008; Danner-Schröder, 2016; Danner-Schröder and Geiger, 2006). Mindfulness in routines implies 1) "attentiveness to one's context, and 2) the capacity to respond to unanticipated cues or signals from one's context" (Levinthal and Rerup, 2006, p. 504). Five defining principles that are connected with mindful action guide high-reliability organizations:

1) practices are preoccupied with failure, 2) reluctance to simplify details, 3) sensitivity to operations, 4) commitment to resilience, and 5) deference to expertise not experts. (Weick and Sutcliffe, 2007).

While practice-based research on routines has increased in the last decade (Feldman and Orlikowski, 2011) key research gaps remain. First, a growing number of studies on routine change and performance variations have been conducted, but studies on new routine emergence are not available. Second, managers have been identified to have a central role in collective learning process that occurs during routine development but managerial role in routines has not been studied profoundly.

3 Research design and methods

In this chapter, I introduce the research design and methods that I use in this study. First, I restate the importance of this study, and bring forth my ontological and epistemological positioning. Then I move on to introducing the research design and context, and describe my data collection methods. Finally, I describe the data analysis method, and evaluate my research. In addition, ethical considerations of the empirical part of the study are discussed throughout the chapter.

3.1 Research approach

> *"A research design is a logical plan for getting from here to there, where here may be defined as the initial set of questions to be answered, and there is some set of conclusions (answers)"* (Yin, 2003, p. 20)

The aim of this study is to examine the emergence of new routines, and the managerial role in the process. When forming the design of a case study the following five components have the most important role: a study's questions, its propositions, if any; its unit(s) of analysis, the logic linking the data to the propositions, and the criteria for interpreting the findings (Yin, 2003, p. 21). As Yin (2003) points out it is important to conduct case study in a rigorous way since there has been critics towards the nature of case study. Thus, it is essential to plan carefully the case study design.

My research question goes as follows: How do routines emerge in the refining industry and how the emergence is managed? In order to find central aspects to examine, I formulated four sub-questions:

a. What phases can be recognized in the routine emergence?

b. What factors affect the routine emergence?

c. What is the managerial role in the process?

d. How to verify competence in routines?

My research philosophy has onto-epistemological starting points in critical realism, which can be described as a position that sets between positivism and constructionism, implying attributes and viewpoints from both sides (Easterby-Smith et al., 2013). According to critical realistic approach a reality exists independently, but at the same time, is partly socially constructed and ambiguous, indicating that knowledge can be seen as a social practice (Easton, 2010).

A critical realist case approach is seen to be appropriate for "complex, but clearly bounded phenomena such as organizations" (Easton, 2010, p. 123). Moreover, causality is seen as a possibility, and the critical realist approach to case research aims to find out why certain "events happened or are happening and take into account the problems and issues associated with interpreting the empirical data back to the real entities and their actions" (Easton, 2010, p. 128).

Thus, considering my philosophical position, a study of qualitative nature, a case study, was a suitable approach in this study requiring that the research process will be conducted in an in-depth way (Easton, 2010). I aimed to explore a complex phenomenon of routine emergence in its specific context, and gain deep understanding of the phenomenon. I found that a descriptive case study suited my purposes in the best possible way since I posed "how and what" questions, had only little control over events, and focused on the phenomenon in a real-life context (Yin,

2003, p. 5). I see that understanding the role of the particular context is essential in this study. Also, in the case study "the boundaries between phenomenon and context are not clearly evident" (Yin, 2003, p. 13)

I followed Yin's (2003) guideline when choosing between single-case and multiple-case design, and decided to use a single case study design using embedded units of analysis because of the representative nature of the case company in the refining industry. However, Yin (2003, p. 46) enhances the importance of having focus on the holistic view of the case instead of on sub-units of the case.

3.1.1 Company introduction

Neste Corporation (Neste Oil Corporation until July 1, 2015) is a Finnish company that operates on a global market in three business areas: oil products, renewable products, and marketing & services. The company was founded in 1948 to secure Finland's oil supply, its first refinery in Naantali was commissioned in 1957, and nowadays the state of Finland is still the largest owner (50,1%). Neste's revenue was € 11.7 billion in 2016, and the company is traded on Nasdaq Helsinki. The company employs around 5000 people in 15 countries, of which around 2000 people work at the Porvoo refinery. Neste's oil refineries in Finland are located in Porvoo and Naantali, and renewable products refineries in Singapore and Rotterdam. In addition, the Porvoo site produces renewable diesel. Neste also has a joint venture in Bahrain.

Neste's vision is "Creating responsible choices every day", and the company has two strategic targets: 1) Baltic Sea downstream champion and 2) grow in the global renewable feedstock-based markets. Neste has been several years in the Global 100 list of the world's most sustainable companies, and is world's largest producer of renewable diesel that is based on Neste's own NEXBTL-technology.

Neste's values include excellence, innovation, responsibility, and cooperation. The company's slogan is "The only way is forward", and the Way Forward way of working that enhances self-leadership was launched in 2013. Way Forward was developed from employees' ideas on how working practices could be improved in the future.

As managerial role in routines has not been researched in the routine literature, I found it was important to form a deep understanding of the role of management in routines at the case company. Next, I examine competence management and project management at the case company. In the competence management section, I describe the way to manage operator competence, and in the project management section, I outline the different project phases that take place when operating routines emerge in the projects.

3.1.2 Competence management at the case company

Competence is seen as a set of knowledge, skills and attitude that is shown by being able to act skillfully in different situations. There is a continuous need for competence development: organization or customers can bring along new competence requirements, new colleagues join the team and cooperation requires learning, as well as work tasks and practices change.

Competence development includes a competence management project that started in 2014 as a project, and the first new competence management actions were taken in 2015. The project started since there were different competence management practices between different production lines, and between the Porvoo and Naantali refineries. Competence management also varied a lot at the supervisor level. In addition, an increasing number of retirements take place, and new employees start their work. These issues lead to different competence levels and to possible disruptions in the production.

However, there were good practices as excel versions in the production lines as well, and in the project, these good practices have been developed into a systematic model. Basis for the project was to develop a competence management model that follows the one refinery concept: same procedures take place both in Porvoo and Naantali.

Competence management project aims to develop both occupational safety and process safety by implementing systematic competence management practices that e.g. decrease the amount of human errors in production and logistics. Accordingly, the aim is to decrease the amount of safety deviations and production losses that are caused by operational mistakes.

The competence management project has its basis in systematic and transparent competence management model that was developed during the project. The competence management model offers a frame for systematic and transparent competence management in the daily work of supervisors and defines a basis for a systematic way to acquire process unit competence and to verify that competence. In addition, systematic practices for work induction are defined in the model.

The competence management model at Neste consists of the following parts:

1. **Induction period** aims to offer a basic competence in order to pass an operator test after six months. The model sets basis for systematic induction.

2. **Unit competence development** includes a systematic training agenda to acquire a process unit competence. Competence requirements are defined in the program that consists of both theory and practical modules, such as self-study (instructions etc.), on-the job training, practical exercises, simulator training (where in use), and competence assurance.

3. **Refresher trainings** set practices for maintaining and updating process unit competence. The program takes place on an ongoing basis and includes e.g. the implementation of critical instructions (new and updated instructions), disruption training, learning from events, work experience in a unit, simulator training (were in use), and ensuring of practical competence.

During the project, competence management system "Licence to operate" (L2O) was developed. "License to operate" thinking is used: only people who have the unit competence can be responsible for the unit. The idea was to develop a tool that would support the daily work of production and logistics supervisors in competence management, including future competence planning. Competence management is part of supervisors' daily activities, and competence is verified on an ongoing basis. Moreover, individual's responsibility for own development and dialogue-based management culture are emphasized. However, the new competence management model requires that the developed practices will be also implemented in the daily work. This requires understanding of roles and shared ways of working.

3.1.3. Investment projects in general at the case company

Each investment project and process environment is unique but there are some common features that can be identified. Investment projects at Neste consist of the following phases:

1. Idea Creation: idea evaluation and development

2. Pre-Study: identification and evaluation of alternatives

3. Feasibility Study: defining and selecting one final technical solution

4. Project Definition / Basic Engineering Phase: defining scope, cost estimate and time schedule for execution phase

5. Execution phase

    a. Construction phase
    b. Commissioning phase: start-up preparation
    c. New plant start-up

6. Phase after the start-up: production runs in a process plant

7. Post Evaluation

In the execution phase, Neste's responsibility grows: an essential part of the execution phase is to write and comment on work instructions specific to the process unit, and train the new way of functioning. During the execution phase safety issues, legislation and instructions guide project work since the project area is a construction site in practice. During the commissioning phase, specific preparations for the start-up are conducted, and the project area is still a construction site in practice. During the new plant start-up and the phase after the start-up

official responsibility is transferred from project organization to production or logistics organization, which starts to operate the new plant.

3.1.4 Main actors in the investment projects

In the following, I present project actors, and then summarize their roles in table 5.

Neste project organization

Project organization mainly consists of steering manager, commissioning manager or project technician, plant supervisor, plant engineer(s), production supervisor and project operators. Steering manager is Neste's main representative and makes sure that "the project goes as planned", whereas commissioning manager is the main technical representative.

Commissioning manager comments on plans until the plant is in production as well as is involved in the phase after the start up where new troubleshooting and problem-solving activities potentially take place. One of the interviewees emphasized that commissioning manager should be nominated right from the start since this person is part of process design and vision creation that guides the project.

Project plant supervisor has a central role in commenting on the process design, and making decisions related to technical aspects and having cost awareness, whereas plant engineer has responsibilities related to the process design, instructions and trainings among other project work. Production supervisor has a significant role as a leader of the project operator group, and key position when planning the new routine learning process of operators and ensuring the required level of competence in the routine.

Project operators have different responsibilities related to operational/availability aspects, such as designing and commenting on work instructions (what instructions are needed, how they should be written, and what they should include), writing training and competence assurance material, and drawing operations charts. In addition, project operators may participate in hazops (hazard and operability studies) and other risk assessments, as well as put into use commissioning packages and plan the unit start-up. The tasks and level of involvement vary between the projects.

Neste Jacobs

The main engineering contractor and project manager for most of the investment projects is Neste Jacobs. There is a long history and close cooperation between Neste and Neste Jacobs: Neste Jacobs was an engineering department of Neste for over 40 years (1956-1999), and then the engineering department was corporatized. Nowadays Neste Jacobs is 60% owned by Neste and 40% owned by Jacobs Engineering (http://www.nestejacobs.com). Neste Jacobs head office is located in the same area as the Neste Porvoo refinery. In the projects, it is important to verify that Neste Jacobs has a sufficient level of Neste specific competence.

Contractors

Contractors have a central role in the investment projects since they are doing the actual construction that is tightly connected with safety issues and operational aspects, but due to the scope of this study their role is not examined further.

Process Licensor

Process licensor offers licensed process unit technology, and engineering design and guidance related to the new process unit.

Table 5 Main actors and their roles in the NCON, SDA and VRU projects

Actor	**Project role**
Steering Manager	Main client (Neste) representative.
Commissioning Manager	Main technical client (Neste) representative. Commissioning - start-up preparations.
Project Technician (only in VRU)	Main technical client (Neste) representative. Start-up preparations.
Plant Supervisor	Responsibilities related to process design and technical aspects.
Plant Engineer	Responsibilities related to process design, instructions and trainings.
Project Operators (only in SDA and NCON)	Part of project group: responsibilities related to operational aspects, instructions and trainings.
Production Supervisor (only in SDA and NCON)	Supervisor for project operators.
Neste Jacobs (Project Manager, Lead Engineer, Process Design Engineers and Inspectors)	EPCM contractor: Key position in offering engineering, procurement, construction and project management services.
Production organization	Cooperation with operations, supervision, and maintenance departments. Some representatives included in the project group.
Logistics organization	Cooperation with logistics organization.
Safety (Safety Coordinator, HSE Managers)	Safety-related responsibilities.
Contractors	Actual construction.
Process Licensor	Planning and guidance related to the new process technology.

3.1.5 Embedded cases SDA, NCON, and VRU

I examined three investment projects at Neste (embedded cases): NCON (Naantali configuration), SDA (solvent deasphalting), and VRU phase 1 (vapour recovery unit). NCON project changes the configuration of the Naantali refinery, which leads to a more efficient and simpler production. SDA project takes place at production line 4 at Porvoo, and aims to decrease the share of asphaltene in the vacuum residue hydrocracker supply: larger share of crude oil can be converted into high value and high quality fuels. VRU project was implemented at the Porvoo harbor. The project aimed to decrease the amount of VOCs (Volatile organic compounds) at the harbor to the level that is required by the environmental permit limit.

I decided together with my thesis supervisor at work to choose these specific cases since they lead to very new or changing operational routines. In addition, NCON and SDA projects are significant investments and large-scale projects at the company. The projects also represent both production and logistics organizations at the case company. The projects will broadly affect operational routines: changes at the NCON project at the Naantali refinery will also affect routines at the Porvoo refinery, and the new SDA unit will affect other routines. One motivation to examine VRU project was that competence in new operating routines varied when the project was implemented. In addition, the projects are in different phases: VRU project was completed in May 2014, SDA commissioning takes place in Q2 2017, and NCON commissioning is scheduled for summer 2017.

3.2 Data collection

I collected data from multiple sources. Yin (2003, p. 85) presents six important sources for collecting evidence in a case study: documents, archival records, interviews, direct observation, participant-observation, and physical artefacts. Yin (2003, p. 85) also points out that multiple other sources of evidence can be listed. Moreover, Yin (2003, p. 97) introduces three principles of data collection that enhance the reliability of a case study: multiple sources of evidence, create a case study database, and maintain a chain of evidence. As Yin (2003) suggests, I see that relevant sources of data include multiple sources of evidence, being the following ones in my study: participant-observation, interviews, and documentation.

In general, I had a flexible approach towards the study, meaning that I made suitable adjustments to the data collection during the process when needed based on the emerging themes (Eisenhardt, 1989). Yin (2003, p. 59) supports this view by stating, "An inquiring mind is required during data collection, not just before or after the activity in case studies". Besides adaptation and flexibility it is important to have an ability of being a good listener, which implies "being able to assimilate large amounts of new information without bias", and have a basic understanding of the issue studied (Yin, 2003, p. 61).

3.2.1 Participant observation

I have participated in the competence management and operator learning activities in the roles of competence developer (summer trainee) and competence specialist at the Porvoo refinery. This setting has enabled me to gain a relatively deep understanding of the context of the case company, and the activities happening in the field of operator competence and related operating

routines. Yin (2003, p. 94) notes that participant observator role makes it possible to gain access to specific events, and to see the reality from the perspective of "someone inside the case study rather than external to it".

However, the participant observer may encounter some potential bias, e.g. having the inner thought of acting as "a supporter of the organization, and missing some relevant observations when the focus is on the participant role" (Yin, 2003, pp. 95-96). I understood my role as a participant observer, and the related challenges. I see that in this study, my participant observation method works as a tool to understand the specific context, and enabled e.g. observation of the operator work.

I became familiar with the procedures, safety regulations and culture of the case company, and got a basic view of the operational routines. In order to form a realistic and comprehensive view I made field notes, and participated in multiple formal meetings and informal discussions. The formal meetings, including e.g. project discussions and field tours, are summarized in table 6 below.

Table 6 Formal meetings

Participant(s)	Topic	Date	Duration	Location
Steering Manager	General discussion about NCON project	8.12.2016	30 mns	Online
Steering Manager & Commissioning Manager	General discussion about SDA project	8.12.2016	30 mns	Porvoo
Development Manager	Reliability in investments & project work	8.12.2016	30 mns	Porvoo
Harbor Manager & Project Technician	General discussion about VRU project 1. phase	3.1.2017	45 mns	Porvoo
Steering Manager & Commissioning Manager	Field tour at NCON project site & discussion about the project and competence management	9.1.2017	2 h	Naantali
Harbor Supervisor & Operator	Visit at the harbor / VRU panel	24.1.2017	15 mns	Porvoo
Commissioning Manager	Field tour at SDA project site	27.2.2017	1 h	Porvoo

3.2.2 Interviews

Yin (2003, p. 89) describes interviews being more like "guided conversations" which reflect the nature of this method. In order to get a comprehensive understanding of the cases, I conducted 15 semi-structured interviews that are summarized in table 7. Interviewees 9 and 10 participated in the same interview. The interviewees had varying background and roles in the organization, which enabled multiple perspectives. I conducted the interviews at the Porvoo or Naantali refineries or online.

Table 7 Interviews

Interviewee	**Project Title**	**Date**	**Duration**	**Location**
Interviewee 1	Steering Manager	18.1.2017	54 mns	Porvoo
Interviewee 2	Commissioning Manager	18.1.2017	41 mns	Porvoo
Interviewee 3	HSE Manager	18.1.2017	41 mns	Porvoo
Interviewee 3	HSE Manager	22.3.2017 follow-up	25 mns	Porvoo
Interviewee 4	Steering Manager	20.1.2017	31 mns	Online
Interviewee 5	Plant Engineer	20.1.2017	21 mns	Naantali
Interviewee 6	Operator	24.1.2017	32 mns	Porvoo
Interviewee 7	Steering Manager	24.1.2017	19 mns	Porvoo
Interviewee 8	Project Technician	24.1.2017	33 mns	Porvoo
Interviewee 9	Operator	24.1.2017	46 mns	Porvoo
Interviewee 10	Harbor Supervisor	24.1.2017	46 mns	Porvoo
Interviewee 11	Plant Engineer	27.1.2017	27 mns	Porvoo
Interviewee 12	Operator	27.1.2017	32 mns	Porvoo
Interviewee 13	Operator	27.1.2017	24 mns	Porvoo
Interviewee 14	Commissioning Manager	30.1.2017	38 mns	Online
Interviewee 15	Production Supervisor	31.1.2017	36 mns	Porvoo
Interviewee 16	Development Manager	3.2.2017	23 mns	Porvoo

The interviews were based on an interview guide that can be found in Appendix I. In this study the questions were open-ended, which is recommended by Yin (2003, p. 90). The semi-structured interviews allowed me to get descriptive answers that suited my research objectives. I slightly customized the interview guide according to the role of the interviewee. In addition, during the interviews I took notes, and asked further questions when needed.

3.2.3 Documentation

Yin (2003, p. 85) sees documentation as a relevant source of data in almost every case study. Yin (2003, pp. 85-86) presents a wide spectrum of documents, including e.g. letters, agendas, minutes of meetings, and other written reports of events, internal records such as administrative documents, and newspaper clippings. I collected different documents, including corporate presentations, annual reports, project sites, training material, guidelines, internal project newsletters, and internal portal news. The artifacts helped me to get a better understanding of the context where the cases take place. They also provided me with codified descriptions of operating routines.

3.3 Data Analysis

The analysis process already began when I started to collect and transcribe the data, but I did a proper systematic analysis after I had transcribed all the gathered data. I recorded and transcribed all the interviews word-to-word, but left out filler words. I transcribed the interviews within week after I had conducted the interview. I used ATLAS.ti program as the analysis tool to analyze the data. I chose the method of thematic content analysis, and used codes that I defined both before (relevant codes derived from the search questions) and during the data analysis (emerging codes derived from the data). I analyzed the data with an inductive approach (Miles and Huberman, 1994).

In the first stage of data coding I carefully read the data and identified all statements that were related to the research question and sub-questions. Then I assigned a code or category for each statement. After this, I reread the data, and searched for statements that may belong to any of

the categories. In addition, I developed some new codes in this stage. After I had completed the two stages of coding, I started to look for patterns and explanation in the codes more comprehensively, e.g. combined some codes under a more general code and identified causal relationships, and organized codes sequentially. Finally, I read the interviews again and looked for cases that explain the concepts and both confirmatory and contradictory data, being aware of not being selective in choosing data.

3.4 Evaluation of the Study

This thesis was done as a commission for Neste, which somewhat guided and limited the focus of this study. However, together with the commission company and my thesis supervisor, we formulated a relevant way to approach the topic from the theoretical and empirical perspectives.

In order to ensure a high quality of my research I familiarized myself with four tests "commonly used to establish the quality of any empirical social research": construct validity, internal validity, external validity and reliability (Yin, 2003, p. 33). The tests, identified case study tactics and phase of research in which tactic occurs are summarized in table 8 below.

Table 8 Case study tactics for four design tests

Tests	**Case study tactic**	**Phase of research in which tactic occurs**
Construct validity	- Use multiple sources of evidence - Establish chain of evidence - Have key informants review draft case study report	Data collection Data collection Composition
Internal validity	- Do pattern-matching - Do explanation-building - Address rival explanations - Use logic models	Data analysis Data analysis Data analysis Data analysis
External validity	- Use theory in single-case studies	Research design
Reliability	- Use case study protocol - Develop case study database	Data collection Data collection

Source: COSMOS Corporation, Yin (2013)

When thinking about construct validity I used the approach of having multiple data sources, including three sources of evidence: participant observation, interviews, and documentation, which lead to data triangulation as suggested by Yin (2003). In addition, the amount of interviews was quite high, and included multiple perspectives, and roles related to the cases. All of the interviews were conducted in Finnish, which is a native language for the interviewees and me, which lead to a good level of expression. In addition, I made sure that the interviewees wanted to participate in the research on a voluntary basis, and asked for permission to record the interviews.

Evaluation of the internal validity is not relevant for this study since the study is descriptive, and the tactic is only used in explanatory or causal studies (Yin, 2003). External validity implies "whether a study's findings are generalizable beyond the immediate case study" (Yin, 2003, p. 37). Rather than reflecting only the single cases in their specific context, I covered broader theoretical issues, including routine emergence and the managerial role, in the field organizational routines.

Besides having multiple data sources, I created a case study database, and maintained a chain of evidence. Accordingly, a chain of evidence from the case study questions to the conclusions can be seen in the study, which enhances the reliability of the study. As Yin (2003) suggests people at the case company read the empirical findings and case descriptions, and provided me with feedback. This was an important part of verifying the descriptive validity of my findings (Yin, 2003). In addition, my work experience at the refinery has given me some insights related to the company culture and procedures. Thus, my interpretations can be seen trustworthy.

4 Empirical findings

The findings, which are summarized at the end of this chapter in figures 7 and 8, are presented in this chapter. First, I present refinery environment that works as the case context. Second, I outline the three cases: NCON, SDA, and VRU, which all are change projects to increase profitability or to meet environmental regulations. Summary of the studied cases is presented in table 9 below.

Table 9 Summary of the NCON, SDA, and VRU projects

Case	**Aim**	**Scope**	**Execution timeline**
NCON (Naantali Configuration)	To change the configuration of the Naantali refinery which leads to a more efficient and simpler production (closure of some units).	Naantali production, logistics between Porvoo and Naantali refineries.	2015 - Summer 2017
SDA (Solvent Deasphalting Unit)	To decrease the share of asphaltene in the vacuum residue hydrocracker supply: larger share of crude oil can be converted into high value and high quality fuels.	Production (production line 4), Porvoo refinery.	2015 - Spring 2017
VRU (Vapor Recovery Unit) 1. phase	To decrease the amount of VOCs (Volatile organic compounds) at the harbor to the level that is required by the environmental permit limit.	Harbor, jetties 3 and 5, Porvoo refinery	Fall 2011 - Spring 2014

Third, I have a closer look at the new routine emergence that can be divided into three main phases: new routine content definition, new routine learning, and new routine implementation in practice. I bring up special issues related to operator involvement in the projects. Throughout the chapter, I examine the role of competence management in routine emergence. Finally, I examine the managerial role in new routine emergence.

4.1 Case descriptions

The purpose of this section is to give a good understanding of the refinery context in which the projects take place, and describe the three embedded cases: NCON, SDA, and VRU projects. All the projects include multiple operating routines that will remain, change or need to be unlearned, and new routines will emerge. The new way of functioning after the projects is summarized in table 10 at the end of the section.

A process operator is a blue-collar worker in production or logistics at the refinery. Operating routines can be divided into field operator and panel operator routines. Safety and different artifacts, including multiple guidelines, guide them both. Field and panel operators work in a close cooperation by using e.g. radiophones to communicate.

Daily operating routines require careful assessment of the process and needed actions. Operators adjust the process, and sometimes they need to make quick decisions in disruptions that are mostly unfamiliar situations.

4.1.1 Case context: refinery environment

Each refinery, an industrial process plant, has its unique configuration of connections between different unit processes and intermediate product streams. Refinery configuration determinates what happens between the feedstock and intermediate products: various physical and chemical processes take place. There are four production lines, and over 40 process units at the Porvoo refinery, whereas one production line and around 30 processes are located at the Naantali refinery. The Porvoo refinery manufactures around 150 products or components, and the corresponding number is around 120 in Naantali. The refinery functions are divided into production (operations, supervision, and maintenance) and logistics (harbor and terminals).

Safety rules, legislation, and permit conditions guide and regulate the refinery work: a high level of safety is a key factor in every action, and environmental permit sets requirements for monitoring emissions and the environment. Safe working methods, safety discussions, observation tours, inspections, and risk evaluations enhance safety.

Field operator's central areas of responsibility include monitoring and operating the equipment, and conducting field tours (including needed measurement, data collection, and reportage). Panel operator controls operations of each unit from a control room using an automatic system, optimizes the process units against the targets as well as makes analysis requests and changes in the operations based on the analysis results.

In addition, key operator task is to eliminate process disruptions in the earliest phase possible. Sometimes part or all the operations need to be taken down: a shutdown is an unplanned disruption in the refining process. In disruptions, also automatic process protection systems

take place. Disruption- and incident-free operations enable a higher level of safety and product yields. Since most of the units operate continuously, operators work in two shifts at Neste. There are six working shifts at the Porvoo refinery, and four at the Naantali refinery

4.1.2 One Refinery concept

One Refinery concept is a refinery change program that Neste launched in 2015. The program takes place in Porvoo and Naantali refineries in Finland until mid-2017. The aim of the program is to integrate the Finnish refinery functions more closely together, manage them as one entity, and develop best practices at the refineries.

Integration refers to investments, clear roles, as well as product flows, and shared ways of working between the Porvoo and Naantali refineries. In practice, One Refinery concept means learning new techniques and ways of working, such as working together, as well as sharing and adopting new information. Competence development is one part of the One Refinery - Refining best practices.

Moreover, operational reliability will be based more strongly on logistics and operations in both locations. Thus, both successes and disruptions at one refinery will affect the operations at both refineries so operational reliability and availability require active and systematic planning and collaboration.

Next, I describe the cases by presenting the different project contexts, bringing up similarities and differences between the projects, and outlining the new way to function after the projects.

4.1.3 NCON

NCON, Naantali configuration change project, will be finalized during One United Turnaround 2017 at the Naantali refinery. A turnaround is a planned break in production so that maintenance work may be carried out. During a major turnaround, the process area is somewhat similar to a construction site. Naantali Turnaround 2017 includes both maintenance work and investment portfolio. The change will lead to a more efficient process, to a simpler production at the refinery, and there will be savings in the production costs. Consequently, high utilization rate of process units will be emphasized.

The project work started in 2015, and the project is conducted in cooperation with Neste Jacobs using EPCM model (engineering, procurement, construction and project management services) because of a complexity of a large project. Construction work started in the process area in September 2015, and year 2016 was an intensive construction phase. All the activities take place inside an ongoing process plant during the construction phase, which sets its challenges. Commissioning will take place in fall 2017 at the Naantali turnaround.

The current configuration (until summer 2017) at the Naantali refinery has been in place for several decades. Operations are based to great extent on central, interconnected units. It can be said that Naantali refinery works as its own entity and cooperation with the Porvoo refinery is in a minor role. Turnaround 2017, including the NCON project, is the most significant change project that has taken place at the Naantali refinery.

The single biggest change in the NCON project is the shutdown of a few units. Since many of the common systems are linked to the current units, very new process units and systems are

constructed in Naantali. Thus, it is important that operators understand the new big picture of the refinery, including the changing product streams and the new interconnected process.

Besides the unit decommissionings, NCON leads to new unit operations both in the field and panel based on mainly three changes: new systems and a brand new unit will be commissioned, new equipment will be constructed, and modifications to current systems will be made to fit the new configuration. The panel operators monitor the process of different units from their screens, and NCON will change the division of units at the panel. This means that, after the project, operators monitor new units and new combinations of the existing units. Accordingly, operators need task specific training in order to get knowledge about the operating circumstances of the new equipment and special features of the new technology.

Since the NCON takes place at the same time as other maintenance and other investments in the turnaround 2017, changes will be made to the existing units as well. Unit shutdowns, a new unit and product changes also require that operators unlearn some previous operational routines that are related to specific units, systems and devices. The process area will be the same physical size after the configuration change. Moreover, harbor traffic (number of shippings) will increase somewhat both in Porvoo and Naantali, which requires more flexible port operations. Thus, the new model requires fluent cooperation between the production and logistics organizations.

In the future, the Naantali refinery will not refine all the feed molecules into finished products, which implies that the refinery becomes production line 5. Thus, after the NCON change, the new configuration requires increased cross-functional cooperation between the Naantali and

Porvoo refineries. This means that cross-functional communication will have a growing role in the daily work operators and other employees.

4.1.4 SDA

In 2014, Neste decided on constructing a new SDA (Solvent Deasphalting) unit and asphaltene pelletizer, which is an integral part of the unit, at the area of production line 4 (PL4) at the Porvoo refinery. The aim of the SDA unit is to decrease the share of asphaltene in the vacuum residue hydrocracker supply.

The new unit enables to decrease the production of heavy fuel oil and increase the production of diesel, among other things. Even larger share of crude oil can be converted into high value and high quality fuels whose emissions during their use are lower than those of heavy fuel oil. The investment project is due for completion in 2017, and the unit start-up takes place in Q2 2017.

As described above, SDA is a change project that leads to commissioning of the new pretreatment unit for PL4 feed. Before the construction of the SDA unit, operations in different process units take place in the PL4, and most of these operations will remain. Since SDA unit does not exist, there is a higher share of asphaltene in the vacuum residue hydrocracker supply.

However, the SDA unit, consisting of the process unit and the asphaltene pelletizing section with the related storage and loading equipment, brings along new operations. The unit separates asphaltene, and the process is partly very new to operators at the refinery. SDA produces two

products, which are directed further to other units. Thus, the unit enables production of new products for Neste, and operators need to learn the new product features.

The use of new feedstock leads to operational changes at PL4 since one unit will be operated in different ways after the construction of the SDA unit. Thus, operators will learn the new methods, and the current operating method must be unlearned. In addition, import from the Naantali refinery, will increase which requires a close cooperation between production and logistics at the Porvoo and Naantali refineries. The products may also be collected into a storage tank, which means changes in the tank farm operations as well.

When having a closer look at the new operations of the SDA unit some new equipment and processes can be identified. There are basic devices in the unit e.g. furnace, pumps, air coolers, and heat exchangers that exist in other units as well but each unit has its own ways of operating. Thus, the devices are somewhat familiar but operators need to learn the new unit specific operations.

In addition, there are some unit specific processes, systems, and devices. Operating procedures include e.g. SDA specific normal operations, start-up and shutdown procedures, action in disruptions (troubleshooting and problem solving) as well as adjustment and control. SDA unit implies also some changes in the OSBL area (Outside Battery Limits, storage area), which affects other production lines.

4.1.5 VRU

VRU (Vapor Recovery Unit) is the first process unit at the Porvoo refinery harbor. Vapour emission control systems collect vapors of flammable cargoes from tanker cargo tanks during cargo loading. The investment decreases the amount of VOCs (volatile organic compounds) at the harbor to the level that is required by the environmental permit limit. The project phase 1 included the construction and commissioning of vapor emission control system on tankers, and related VRU package in jetties 3 and 5. The project took place from fall 2011 until spring 2014. In the phase 2, the system will be extended to other jetties, too.

The old way of functioning, before the VRU project, means that vapor emission control systems do not exist, and the cargo is not collected. VRU is based on an activated carbon process, so operations related to this process are not done either.

Accordingly, the VRU routines that emerged after the project were mainly very new in the harbor. Equipment was somewhat familiar in the field e.g. pumps, fan, and heat exchangers so the new field operations were somewhat known. However, e.g., absorbent tank and DSU (dock safety unit) operations were new in the field, and VRU operations were very new in the panel. In addition, the automation system changed at the same time in the panel.

VRU operations require daily monitoring and control. Operating procedures include testing and inspection of equipment, pre-transfer procedures, piping connection sequence, start-up procedures, normal operations and emergency procedures (automatic shutdown systems). The new system also requires understanding of the associated tanker equipment as well as purpose and operating principles of the vapor control system and knowledge of the associated hazards.

To conclude, the three projects are change projects, and have unique operating environments. First, NCON, taking place at the Naantali refinery, can be described as a fundamental change that reconfigures the big picture of operations. Second, construction of the SDA unit, taking place at the production line 4 in Porvoo, is a new process unit that can be seen as an add-on to the current operations but requires fundamental change. However, SDA includes unfamiliar processes, and the unit affects current operations at the PL4, at other operations as well, which requires changes in some existing operations. Third, VRU was the first process unit at the Porvoo harbor. Thus, the unit operations and process in general was very new to the harbor operators.

Table 10 New ways of functioning after the NCON, SDA, and VRU projects

	NCON (Naantali Configuration)	**SDA (Solvent Deasphalting Unit)**	**VRU (Vapor Recovery Unit) phase 1**
Remaining routines	1. Most of the existing unit operations remain unchanged.	1. Most of the operations that take place in the production line 4 remain unchanged.	1. Other than VRU related harbor operations remain
Changed routines	1. Modifications to system operations and devices. 2. Changes in logistics operations. 3. Changes in some other existing unit operations. 4. Increased cross-functional cooperation between the Naantali and Porvoo refineries.	1. More dynamic operating method at PL4. 2. Changes in the tank farm operations.	-
New routines	1. New unit operations. 2. New operations related to new systems and devices.	1. SDA unit operations related to new systems and devices. 2. Pelletizing section operations related to new systems and devices. 3. Increased cross-functional cooperation between the Naantali and Porvoo refineries.	1. Vapour emission control operations in the field and related equipment (e.g. absorbent tank). 2. VRU operations and a new automation system in the panel (e.g. startup and normal operations procedures).
Unlearned routines	1. Closed unit operations. 2. A few other unit operations.	1. Stable operation method at PL4.	-

4.2 Routine content definition

The purpose of this section is to understand the process of content definition and competences in routines. First, I discuss the role of artifacts and communication in operator work in general, and during the project. Then I move on to examining routine content, and the role of competence management in the content definition. In addition, I bring up issues related to operator involvement in the process of new routine emergence.

4.2.1 Role of artifacts and communication

Artifacts, ranging from operating procedures, instructions, checklists, and piping and instrumentation diagrams (P&ID) to different tools needed in operations, have a salient role in the daily work of operators. There are hundreds of official guidelines at the refineries that include e.g. descriptions of unit processes, normal operating procedures, equipment instructions as well as instructions on how to act in different disruptions and how to start-up and shut down process units. P&ID is a detailed diagram that shows the interconnection of piping and vessels as well as instrumentation (measuring instruments) used in the process control. In these drawings, a standard set of symbols is used. The written guidelines are complemented by the drawings of P&IDs. As one interviewee stated, operating competence is largely based on instructions: "*Basic competence has its basis on instructions"* (Interviewee 7).

In some cases, operations were seen to be mostly in mind, not on a paper since experience is a strong guideline especially among experienced workers. Nevertheless, it is part of the operator competence to use checklists and instructions when needed, e.g. in disruptions, and not to trust

just on memory. In most deviances and "close calls" at the refineries one cause is a human person forgetting actions depending on one's memory. However, the quality and readability of guidelines varies. This topic has gained attention at the refineries, and plant engineers together with the operators are improving the content of the guidelines. In addition, new instructions and especially quick checklists are being written to suit situations where a need for a codified task has been identified. More and more quick checklists are also available at the field. To summarize, instructions and quick checklists have a significant role in supporting and guiding the daily operations.

Guidelines either describe the operating procedures and actions in a very detailed way, or define the desired outcome, depending on the situation. However, it is clear that there cannot be instructions for every disruption since the interviewees described that almost every disruption is unique. This means that operators need to understand the process, and the need to apply in some situations; so operators need logical thinking in order to make informed decisions:

> *"In some way you have to be flexible so you need to adapt to different situations, even though we do have these checklists and so on, since there can always come out something surprising. You cannot get totally confused, you need to have the ability to consider: what to do in this situation, and how would I act in this situation."* (Interviewee 1)

Moreover, interviewees saw that a too detailed guideline that describes e.g. actions step by step in a disruption may even make the situation more complicated. On one hand, you need to follow the instruction, but on the other hand, you need to adapt since the disruption is slightly different

than described in the guideline. Thus, interviewees saw that in many cases it is better to describe the desired outcome, which gives operators room for searching and combining suitable actions, following the safety principles. However, usually operators need to make the most critical decisions during the first minutes so the enactment of routines requires a good knowledge of the possible set of actions that are not always pre-determined.

Investments projects are massive projects, and employ people outside the project group. This leads to a challenge of how to get all people engaged with the project. People may not work with the project on a full-time basis but by the side of their other work tasks:

> *"It is always challenging when there is a nominated project group who does the project but at least the same amount of people is needed from all others who work by the side of their own work. That is a big thing how to get all involved."* (Interviewee 2)

Discussions between actors are seen highly important, and workspaces as artifacts may enhance (or restrict) communication. For example in the SDA project, different project actors are physically placed in construction barracks, which are located side by side. This arrangement enables a smooth communication from operators directly to e.g. Neste Jacobs inspectors. In addition, it was highlighted that team building and knowledge sharing requires effort and systematic practices in order to get a team to work together. In addition, it is seen important to get different project actors in key roles, including operators, process design engineers, and contractors, to discuss. Informal discussions are seen to support communication and are valuable as such, but systematic meeting practices where "*people meet and systematically discuss the right things"* (Interviewee 3) are valued over the informal activities. When people

work next to each other, both formal and informal discussions take place on a more regular basis.

The emphasis is on the part "to systematically discuss". I have come across that at the refinery informal discussions take place, and they have an utterly important role in team building, and knowledge sharing. However, more or less critical information should have its basis on systematic meetings and discussions that the participants document, too. When e.g., operators and other participants have discussed past or possible future disruptions, as well as written down notices and possible actions the next step is to verify that everyone gets the information. In addition, in the best case the operators not just read the information but discuss it together with e.g. other operators and plant engineer so that everyone gets a good understanding.

4.2.2 Competence management in routine definition

It was seen essential to consider what changes the projects bring along in terms of operating routines, and what actions the changes require in competence management. First, new routine content should be defined: what operators need to learn and possibly unlearn. Second, since the process units are somewhat interconnected, and changes in one unit may affect another unit, it is important to take into consideration all the effects: e.g., changes in production lines may affect logistics, as in the NCON project. Accordingly, new routine may affect also some other existing routines, as happens the cases of NCON and VRU, so the content of these routines should be re-examined as well.

Interviewees brought up that steering manager, commissioning manager, shift supervisor, operators and plant engineer form a core team in new routine content definition. Competence management responsibilities should be clearly defined within the people. In addition, project management should consider who needs to acquire a specific competence in the field and panel. Especially in the large-scale projects, the changes may concern a very new unit that includes multiple processes (SDA), or even multiple units and processes (NCON). In smaller projects, the change may imply changed operations on a specific device. However, interviewees saw the unit competence development plan must be made in the beginning of the project:

> *"When we have a good enough view on what this (new routine) means in terms of competence, we should be able to define the (new) competencies. How the competence takes place in investment projects: is there e.g. one competence entirety or three separate entireties? Now when a common frame exists, I would think about following parts: what does this mean per competence, e.g. what is basic level content; what you need to learn, and when moving on to a more challenging content; e.g. what you need to know in disruptions."* (Interviewee 3)

From the interviewee point of view commissioning phase is part of project competence whereas new unit start-up is seen to be its own entity that is about operator expert competence. However, they both are tightly connected with new routine competence, and it is essential to consider what kind of competence is needed in the commissioning phase and in the start-up of the unit, and after the start up over a longer period.

Refinery environment is changing, and sometimes work tasks may totally change when an operator joins a project group, switches product lines or starts to operate a new process unit. Learning new is seen to require clear rules: it should be clearly defined if the operator still

needs to maintain current competences or focuses just on the new unit competence development. Usually this depends on the scope of the project, but needs to be considered in each case. Sometimes besides learning new operators needs to maintain current competences and sometimes learning new is something so broad that operators change their tasks and the old may remain.

4.2.3 Operator involvement in the projects

Interviewees emphasized that operator involvement, illustrated in figure 5, was seen critical in each phase of the project. Already in the basic engineering phase, the most important thing is to identify risks and prevent them, which happens by building e.g. right protection systems. In some projects, operators are actively involved already in the planning phase but this is not the case in all projects.

It was pointed out that it is much better and easier in terms of costs and possibilities to make changes needed already in the planning phase compared to the execution phase. Accordingly, this requires that the operators involved in the early phases are experienced so that they can comment on right things and suggest relevant changes:

> *"Already in the planning phase users (operators) themselves could comment on specific, definite things against the layout; if it is possible at all to place valves here and there, and where they should be placed. The earlier you get the user involved, the better the plan is, and the easier it is to still make the changes."* (Interviewee 3)

Thus, operators can bring up valuable notions based on their operating experience, and as noted by another interviewee, to enhance the safety and efficiency of their work:

> *"An important learning in terms of competence is that you (operator) get involved in the project starting from the basic engineering phase, and by learning and commenting on effect safety and efficiency of your work."* (Interviewee 12)

"Building your own house" was seen as descriptive representation for project operator involvement: you want to build your house in the best possible way, are involved in the planning and execution process, and get to know your future home along the project timeline.

In the NCON project a team of four operators had been part of the project full-time less than a year (in February 2017), but it was seen that it would have been highly beneficial to involve them earlier. Some operators were part of the project on a part-time basis but it sets its own challenges to complete both project work and working shift operator tasks: you cannot do both extremely well. In general, level of operator involvement can be seen moderate during the NCON project.

In the SDA project a few of the operators had been part of the project already one and a half year (in February 2017), and in February 2017 all the 18 operators, who will continue operating the unit in shifts, were part of the project group. Both more and less experienced operators had been longer part of the project group, and then more operators, having varying backgrounds, joined the project group in different project phases. Combination of different experience levels was seen to work well in the SDA project. Of course, in the early phases of the project (including basic engineering phase) extensive experience is needed.

In the SDA project, the project operators changed between the basic engineering phase and execution phase. In an ideal situation, same people would be on the board during the whole

project. However, operator involvement continued successfully in the execution phase, and project management gave operators a lot of responsibility and possibilities to influence and bring up issues from the end-user perspective. Nevertheless, not all the changes that would have been possible to make in the basic engineering phase were possible in the execution phase. In general, level of operator involvement has been high during the SDA project.

In the VRU project, operators were not much involved in the project content, but were mostly informed and sometimes asked to give comments. VRU as a process unit was something new in the harbor, so operators were not experts of the process. In general, operator involvement can be seen low during the project. However, operator involvement is something that was seen worth considering in the upcoming projects in the harbor, since operators learn along with the project, get a deep understanding of the process, and are able to share knowledge to other shift operators.

In general, it seems that involving operators right from the early phases is something that project management would do if possible. Interviewees saw that operators should be part of the project starting from the beginning of the basic engineering phase.

It was emphasized that it is important to give responsibility, that is to say, to give a bigger task to project operators. The goal may be defined but operators should be given freedom to think about how to achieve the targets:

> *"A good way is to share responsibility, to give people a bigger task and goal to accomplish: think how you will do it, in other words, how it should be done. Of course,*

there are differences among individuals, but there are many people who get excited about this kind of challenge when they are given a bigger task." (Interviewee 1)

However, it was pointed out that it is good to keep in mind that even though operators are given responsibility and a chance to influence different things, support and guidance is needed especially when it comes to unfamiliar equipment and processes.

Some of the interviewees pointed out the difference between project work and operator work. They saw that it would be beneficial to train specific project skills to new projects operators since project work differs a lot from the daily operator work in the field or panel. This implies the need to what the project work is, and what that kind of work requires, e.g. sense of responsibility and initiative were seen as good attributes in the project work as well.

When it comes to the nature of the project work it would be good train different project phases and the content of each phase profoundly, e.g. what happens in the commissioning phase. Worksite arrangements, safety and legislation principles as well as Neste specific practices (specifications) and other instructions guide the work largely. Consequently, a deeper understanding of the guiding principles would increase operator commitment to the project work and enhance understanding of different activities that take place during the project. These kind of trained skills would support competence and operators' role in the project work.

It was suggested that there could be a bunch of project operators who would be trained to the project work, and the operators included in the project pool would be involved in many projects. However, this practice requires systematic processes and a longer-term planning.

Figure 5 The process in which operators are involved in the project work starting from the early phases

4.3 Routine learning

The purpose of this section is to examine routine learning, and the role of competence management in the learning process. First, I examine competence management in learning. Second, I describe operator learning in general, including different training methods. Third, I explore how the operator learning took place in the projects. Key training methods are illustrated in figure 6 at the end of the section.

4.3.1 Operator learning in general

Operator work is expert work, and takes place in a high-risk context meaning that in every situation the basis is to conduct tasks safely. Everything starts from the right attitude and motivation to learn new. Then, it is essential to understand basics of the ongoing oil refining process, e.g. impact of temperatures and pressures. Operator work requires mindfulness since

it is critical to understand the big picture, and how different processes and actions are interconnected as one interviewee expressed:

> *"Expert work in which you need to be able understand large-scale entities. Understand that if you do a certain action in one unit, how it also affects other units etc. Understanding the big picture is really important."* (Interviewee 3)

Operators have different backgrounds, experience, and expectations, and all this affects new routine learning. Interviewees emphasized the importance of taking into account the starting level of operator competence: no assumptions should be made of the current competence level. This is something that seems to require more consideration when training new. Even small changes in the process or slightly changing practices are changes: new process technology or new operations may feel unfamiliar or even scary.

Competence management system L2O acts as a basis for managing operator learning and competence assurance at Neste. Accordingly, L2O supports the management of learning, but the actual actions take place outside the system. As one interviewee emphasized, the system itself does not guarantee learning, but supports and enables the basic requirements for learning when the content of each competence and trainings are pre-defined:

> *"Competence management has been strongly enhanced. Competence management system is just one system, you can manage different sectors there but more important is how people are trained in each phase. L2O (competence management system) serves specific purposes but you cannot outsource all the actual doings there. There are so many methods of learning."* (Interviewee 14)

As stated above, the way to train people in each phase is crucial. Target of all the trainings should be to offer the skills, knowledge and competencies needed to perform a specific job safely and efficiently. On the job training (OJT) is a training method largely used at Neste. This kind of direct instruction takes place at the workplace while the employee is doing the actual job. Usually an experienced employee serves as the instructor using hands-on training so the learning happens by doing. Before on the job training is one happens primarily self-study and observational learning in order to acquire the basic knowledge.

However, after the start-up both observational learning, and on the job training as learning methods are available and used regularly. Concerning the way of training, a quality of on the job training was brought up several times. The level of instruction may vary a lot depending on the instructor, and differences in the quality of on the job training are one identified challenge. In the new competence management system, the content of each competence (consisting of operational routines) is now defined, meaning that there is a clear structure for on the job training. It seems that also, the quality of on the job training is getting steadier, but this requires that the defined content will be transferred into action. I have seen that this issue is getting more attention at the refineries, and interviewees felt positive about the new systematic way of acting and managing the learning.

In addition, hands-on training is supported by classroom trainings and e-learning courses. An example of a central classroom training is an individual theory training held by a plant engineer. The training material covers unit operations specific information, such as purpose of the unit in the refining chain, including flow of intermediate product streams, and cost-effective

operations. Classroom trainings were seen to offer a good basis for learning. In addition, e-learning is getting more and more popular also at the refinery environment. However, interviewees saw that it is good to keep in mind that they are just one, supportive part of the learning. E-learning enhances understanding mostly on theoretical aspects, and offer the basis on how to act in practice. Creating good and useful training material requires skills and time, and this is something that should be considered in projects:

> *"Maybe we are facing the challenge that we are having a vision on how to carry out trainings but it is not trouble-free to create either e-learning courses. It requires resources; someone who does trainings that would really be of help (to operators). I am afraid that it is going to be just that kind of training where we will put the slides there and ask to read them, which is not any better than going through them in a classroom, I hope that we get something real there."* (Interviewee 5)

In addition, interviewees saw that suitable training in routine learning is something that should be considered in each case. There are no general definitions of a successful training, but interviewees pointed out that in general, small group sizes in classroom trainings and discussions within own shift work well. Sometimes the most suitable option may be a mix of different trainings:

> *"To divide training into many parts: there are classroom trainings, e-learning courses, and field trainings. You need to consider the starting level of the participants as a basis for all the trainings. I do not know if there is one right way, maybe many ways or some kind of combination."* (Interviewee 8)

4.3.2 Operator learning in projects

As already discussed, active operator involvement in projects is of the utmost importance in order to achieve higher competence levels, and the role of operators varies between the projects. It seems to be critical to involve operators in the planning of trainings. One interviewee pointed out when discussing about good trainings that it is important to ask operators themselves what kind of training they would like to get. Notable is that the training need may vary between projects and learning content. The aim in each project is to train the needed skills to operators so that they will be able to enact the operations in practice.

At the Naantali refinery, some operators have even tens of years of working experience at the refinery, which means that their strongly established operating routines and views on how the refinery works need to be unlearned. The new way of operating the refinery requires also increased communication e.g. within the panel operators about different unit processes. As discussed in the NCON case description, the change requires understanding of the new big picture of the refinery configurations as well as learning of the new or changed ways to operate units and equipment. This has been the guiding principle in the NCON trainings: first to give a good understanding of the new entity and then to provide more specific training Operators have been trained in the form of e-learning courses and classroom trainings as well as by getting to know the configuration by using 3D models and field tours. One challenge has been the high amount of training material.

As discussed before, artifacts, including e.g. guidelines, and piping and instrumentation diagrams (P&ID), play a key role at the refinery operations. Close operator involvement in

forming and commenting on guidelines and trainings is something that has been done in the SDA project. Operators have had an active role in planning and designing trainings and the training material together with e.g. plant engineer and commissioning manager. This leads to a more fundamental learning:

> *"Operators have been doing training material. They have first studied that thing, and then considered what is relevant, what you should know so that you are able to operate the SDA unit. I think they have picked up the key things that are important to operators and operations. And as I mentioned before, when operators have been considering what is relevant, they have also found the relevant competence assurance questions."* (Interviewee 1)

In addition, simulator training has taken place in the SDA projects: since there is not a specific simulator to the SDA unit, the other simulators at PL4 have been used to train some panel operations, and field operators have participated in the trainings, too. In addition, operator involvement takes mainly place outside the direct training context. I came across that in the SDA project operators grow together with the project: they gain knowledge on the process by doing varying tasks such as conduct field visits together with maintenance, participate in workshops and risk assessments, as well as put into use commissioning packages and plan the start-up.

I came across that before one interview SDA project operators started to discuss a problem or new situation, and this occurred spontaneously. Thus, operators learn along the project in informal ways, too. Moreover, in contrast to the NCON, many of the SDA unit operators are

newly recruited, and have different backgrounds, so they do not have strongly established routines of operating the new unit in a specific way.

In the SDA project, also the shift from project work to shift work and the training need of other PL4 operators has been taken into account. Operators have been involved in training SDA competence to operators of each shift at PL4, and cooperation with them is something that has been emphasized. However, it was seen that there could have been even more time allocated for getting to know the new shift.

In the VRU project, learning happened mainly through classroom trainings and discussions with project technician and work instructors as well as within the shift. The project technician also gave specific advice in certain situations. VRU brought along biggest changes to panel operations, field operations were somewhat familiar. The challenge was that a process unit was very new at the harbor, and the possibility to practice actual situations was limited as well as the automation system changed at the same time. Operators had a possibility to do some simulation exercises but they were not equal to real situations. Learning has also occurred by doing in practice, which implies that learning has taken place by operating the unit. Interviewees brought up that during the first weeks of operating new unit, experienced people could systematically guide the actions.

When operators are learning new by conducting tasks during the course of a project it is seen good to make sure that every operator has a chance to do kind of everything, not so that one takes care of just specific things. Of course, depending on the project, some operators may gain special knowledge on something before the start-up. However, when operators get

comprehensive understanding of e.g. the new process unit, they are able to share the knowledge also to other working shift operators as well as answer their questions and considerations related to the new process.

As discussed above, there are many training options, but also some restrictions (e.g. you cannot give simulator training in each case since there are simulators made only to certain situations), and people learn in different ways. When constructing a new process unit the biggest challenge is seen that operators cannot learn in practice by doing, e.g. observational learning and direct on the job training is not possible before the start-up in most cases. One possibility to get this kind of training is to visit another refinery where the given process unit is ongoing. Sometimes operators have a possibility to practice in a simulator that simulates real operating circumstances. However, in most cases, as in NCON, SDA and VRU projects, first steps in learning happens mainly by reading guidelines, and completing different trainings:

> *"Instructions are the basis, so I hope that all operators read the instructions, and understand what is said there, especially in this phase when we have nothing concrete yet."* (Interviewee 11)

After reading the guidelines, it is important to discuss thoroughly the content together by using mental images. This is something that has been done e.g. in the SDA project one day training was organized where the project group discussed possible disruptions, and related actions in these situations.

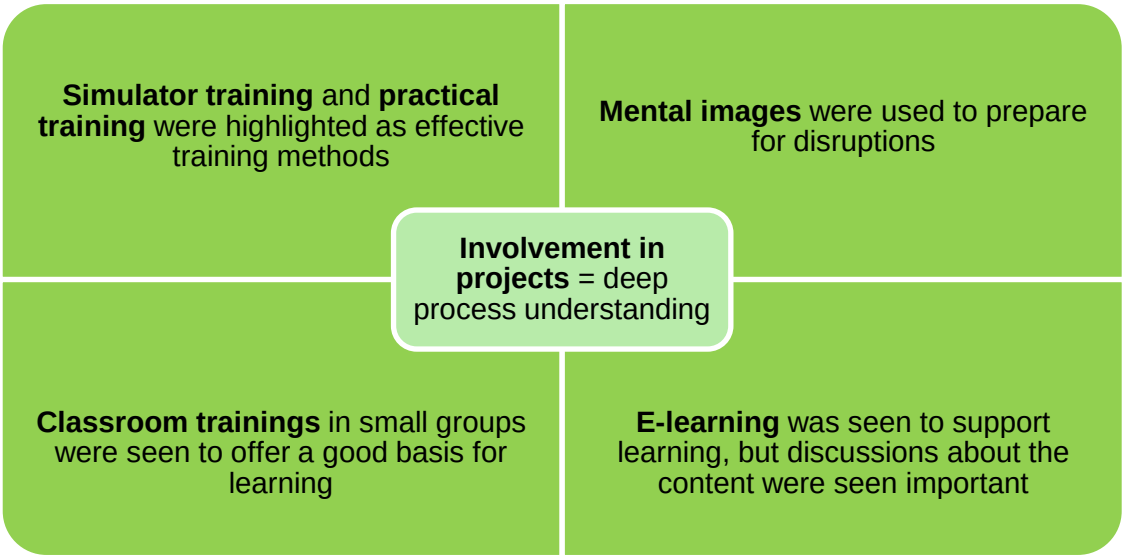

Figure 6 Key training methods in routine learning

4.3.3 Competence management in learning

Interviewees emphasized the importance of having a big picture of the new routines, including a description of the needed competence in routines, a defined number of workers needed in each routine, and a description of their effects on other routines, as discussed in the previous chapter. Accordingly, there must be a plan on what and how to train in each phase of the project. It was seen that a proper training plan (content, target group, and timetable) should be made already in the planning phase, and this plan could be part of the official project documentation. This would also enhance the understanding of the training need. Moreover, at the end of the project an evaluation of the competence management and competence assurance could be part of the project-end report.

In addition, it was brought up that training plan should include a plan on how to train people outside the project group to verify that there is enough competence in all shifts. The plan should include a timeline of how to increase the amount of competent workers, and make sure that there are enough competences in every shift. Interviewees highlighted that it is especially critical when moving from the project phase to shift work, as is the case in the SDA project where a specific project group had been formed. In general, as in the SDA project as well, the project operators will be divided into different shifts.

It was also brought up that knowledge about trainings is needed in the project work. Project group may need support or advice outside the project group when planning the trainings:

> *"Maybe L2O (competence management system) is also better in the sense that it brings systematic approach to this (training). For the first time I had to think about training issues during this project. I see that it would be good to involve someone who is responsible for trainings or someone who has done them before in the project group so that we get good knowledge also about trainings."* (Interviewee 8)

4.4 Routine implementation in practice

4.4.1 Routines in practice

As discussed in the previous section, routine learning takes place in different ways. However, the enactment of routines in real situations, e.g. in disruptions is something very different, as one interviewee described, since operators need to make quick decisions in unfamiliar situations:

> *"In oil refining, it (disruption) must be the most challenging thing. Disruption, you cannot prepare yourself to that in any other ways than by using mental images, reading guidelines and doing trainings but it does not… It is a very different situation when a real process disruption takes place, and you need to make enact most important actions during the first 30 seconds or first minutes so that the process starts to go to the right direction. It requires practical experience and training that only takes place during disruptions, start-ups and shutdowns which are not desired situations, and of course not planned either."* (Interviewee 15)

Still, interviewees saw that it is possible to prepare for disruptions and other deviations to some extent, and use guidelines as supporting artifacts:

> *"If in a disruption situation you (operator) find a checklist that supports your actions, and you have been practiced the guideline in a group before, the situation goes in a different way".* (Interviewee 4).

4.4.2 Start-up of the new process unit

Technology uncertainty is seen challenging in investment projects. Technology licensor has experience and knowledge of similar projects, but each refinery project is still unique. When e.g. building a new process unit a routine enactment takes place just when the unit is ready and there is a real situation with ongoing processes. However, one can prepare for the start-up by studying operating procedures and principles, but things get concrete when the construction is finished.

It was emphasized that after the start-up of the unit, readiness to changes, attentiveness and flexibility are important attributes. Surprises are something to expect, and learning continues by operating, and realizing how the process works. Updates and changes to guidelines are also

something to expect. This implies that operators cannot rely on the guidelines but need to think critically if the operations work as written in the guideline. In addition, observations need to be thoroughly discussed during the first months.

When starting-up the new process plant, in most cases, also operators outside the project group take part in the start-up activities. In general, project operators have a more comprehensive understanding of the new process, and can act as support people:

> *"Learning process of the project team is as long as the investment project itself, so on that basis the support operators in shifts could act in a guiding role and explain things more precisely. Because they have seen why a specific thing occurs in some way."* (Interviewee 14)

4.4.3 Competence maintenance and improvement

During and after the start-up instructions and checklists may be updated or very new ones may be created. A few interviewees brought up that it is important to make sure that the new knowledge is shared and understood both within project operators and within working shift operators. Again, interviewees saw that competence management system can be used in the knowledge sharing and competence assurance, but it is important to make sure also in practice that the changes in the routine have taken place:

> *"Critical point is that in most cases operators have been involved in the project for a long time, and they have been trained. Then we face competence maintenance and situation awareness: okay, during the first 3-4 months (after the start-up) new instructions were created or updated, so how to verify that everyone is aware of the new knowledge. To verify that people, who have been involved in the project and*

worked for a long time are aware of the changes: this many things have changed, and verified that the thing (new knowledge) has been understood." (Interviewee 3)

When implementing a new routine, it is important to pay attention on routines between shifts and even between Porvoo and Naantali refineries. In general, working shifts have different ways of conducting plant operations to some extent: in most cases, this results from a lack of procedures or established routines. This issue is something that is currently being developed in a reliability project since common ways of acting is beneficial for everyone when thinking about safety and cooperation aspects.

During the project period, operators and other people are working together. After the projects, when the work takes place in working shifts it is critical to verify that knowledge sharing takes place, there are common procedures, and clearly defined responsibilities. This implies that different shifts would operate mainly in a similar way and not tailor-made practices for themselves.

4.5 Managerial role in the routine emergence

In this study, management includes all the managerial levels: upper management as well as refinery managers and supervisors. In recent years, management's will to manage competence systematically at the case company has strongly increased: there has been a shift from old competence management practices to new ones, and the change is still ongoing. In general, it is seen that the new competence management system is a good thing, since it enhances safety and makes procedures more transparent and clearer.

One of the interviewees emphasized responsibility of the whole organization in learning and competence assurance. Supervisor is eventually responsible for his/her own team but everything starts from the individual itself, whereas management has the role in developing and maintaining the culture of learning and competence management:

> *"In general, the whole organization, not just supervisors, is responsible for learning and competence assurance. However, willingness to learn starts from the individual. If you do not want to learn, you are not interested or motivated to learn, it does not matter what is going on. It starts with people who are genuinely interested and motivated to learn. Of course, the whole organization has responsibility, supervisor is responsible for his/her team competence, and from that upwards, the whole organization is responsible for learning."* (Interviewee 15)

In addition, management need to "walk the talk" by being interested in the learning process. Accordingly, the importance of showing concrete interest towards learning by discussing the topic and being involved in the process of verifying competence as well as company-wide investments in competence development were brought up several times:

> *"When going up in the organization, when thinking about the people who are responsible for the project they should also be responsible for and interested in learning. In addition, show the interest by being involved in competence assurance, observing that and discussing competence-related topics. Of course, the will is to get as competent people as possible, of course, they find it interesting, but managers could show that they are interested in competence. Accordingly, I have seen that, I think that the direction at Neste has been that there clearly is interest towards competence throughout the organization. There has been investments in competence management.* (Interviewee 15)

However, some of the interviewees felt that the role of upper management in competence management is still somewhat unclear and distinct. In the investment projects, their role is seen to be mainly related to decisions regarding the project resources and schedule. The word resource, referring to project team and other actors, and lack of resources was used multiple times. This varied between the projects indicating that not all the projects are equally resourced in terms of project actors. In general, it is seen that the role of management is to engage in projects, and enable them:

> *"In general, resources are of the utmost importance so that you are able to work. Without resources you cannot do anything in a planned way but you just move from one situation to another."* (Interviewee 14)

Management's will to have and develop competent workers at operating plants is recognized. However, it seems that in the emergence of a new operational routine, it would be beneficial in terms of operational aspects to involve experienced operators more already in the planning phase:

> *"I guess that everyone is sharing the same goal and will: to ensure that things proceed well and the plant starts operating exemplary and people know how to operate. However, what it requires in practice is precisely human investments, people who have sufficient refining experience and understanding of the plant. And you should be able to find them, to ask them to participate in the project already quite in the early phase so that it (the unit) will really start-up properly then."* (Interviewee 5)

> *"The earlier, the better. If you get already in the planning phase a planning group consisting of supervision department representatives and operators it will surely pay*

off. In the future it is easier to implement things through the involved people to other operators." (Interviewee 8)

One interviewee emphasized the necessity of creating an overall plan right from the beginning and the importance of transparency. The plan would include defined roles and responsibilities related to the new routine content definition (what does competence mean in the given routine), content creation (including different tasks at the execution phase), and new routine training.

Learning new requires time, and it was highlighted that there should be designated time to study. Changes in one process unit may also affect the whole production line, so there should be time to study also in the case that the operator will not operate the specific unit. SDA is a new process plant in production line 4, and a bunch of operators outside the project will study the unit competence:

> *"For example, when thinking about operators at production line 4 who will start to operate SDA, production supervisors' task is to ensure that operators are allocated time to study, meaning that resources for learning are offered, so that you can really focus on studying. Not only so that on the side of own job you try to have a look on instructions when operating the unit at the same time. Instead, it would be clearly indicated that now you have a chance to study new. I see that, if you need to follow up the process and study at the same time, one or the other will suffer."* (Interviewee 11)

Production and harbor supervisor's role in operating competence and competence management has somewhat changed. Nowadays supervisor is not necessarily the best expert in operational work but has more managerial responsibilities and role in showing leadership besides being a team member:

"I think that one of the most important tasks of production supervisor is to verify own shift's competence and ensure fluent cooperation in every situation. Based on my understanding, today production supervisors are not so often experts at their own production line in that sense that they are not anymore the best experts in operating units. There are that kind of diamonds too but it is not emphasized the way it was in times past. Operators are best experts in their area of work, and supervisors work as coaches, and keep things together." (Interviewee 13)

In addition, it was seen that supervisor has a role in developing the operator competence, which can happen by giving operators different tasks and responsibilities:

"Managerial role is to have the ability to share work tasks evenly, to make informed decisions on who does the tasks, and to give tasks accordingly. Competence comes along, if you do not study a specific thing, but are given a task, and then you need to learn some new things. Managerial role is to have the ability to give specific people specific tasks. (Interviewee 6)

4.6 Summary of the empirical findings

The findings demonstrate how new routine emergence takes place in a refinery context, and the importance of managerial role in planning the routine emergence throughout the process as shown in figure 7. Competence in routines requires that routine content is defined, learned and implemented in practice. High level of operator involvement seems to have a key role in each phase of the routine emergence. Routine content definition includes consideration of all the changes related to the emerging routine. Routine learning is affected by different training methods, and the interviewees highlighted the importance of planning trainings that are needed

in each phase of the project. The greatest learning seems to take place when routine is implemented in practice.

In addition, organizational structures such as culture and different artifacts may enhance of restrict the routine emergence. Safety culture and shared offices enhanced the routine emergence, but e.g. detailed instructions were seen to restrict adaptation that is needed in most of the operating routines.

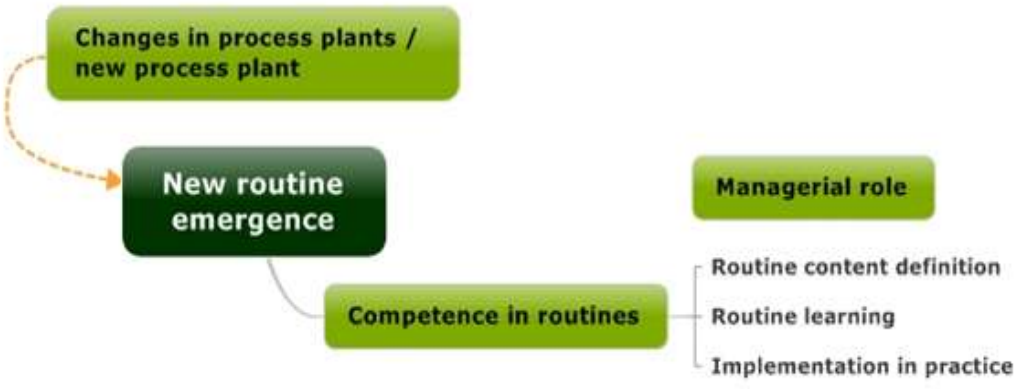

Figure 7 The process of new routine emergence

However, the planned routine may change during and after the start-up of the new unit, which is illustrated in figure 8. Unexpected events and learning may take place; new guidelines or changes to existing guidelines may lead to modifications in the routine. In addition, learning of basic operations requires time. The acquired competence in routines also requires competence maintenance. In addition, competence development takes place when operators start to enact the operating routines regularly. Moreover, it is important to plan and verify

competence in different shifts. Accordingly, competence management is something that takes place on an ongoing basis.

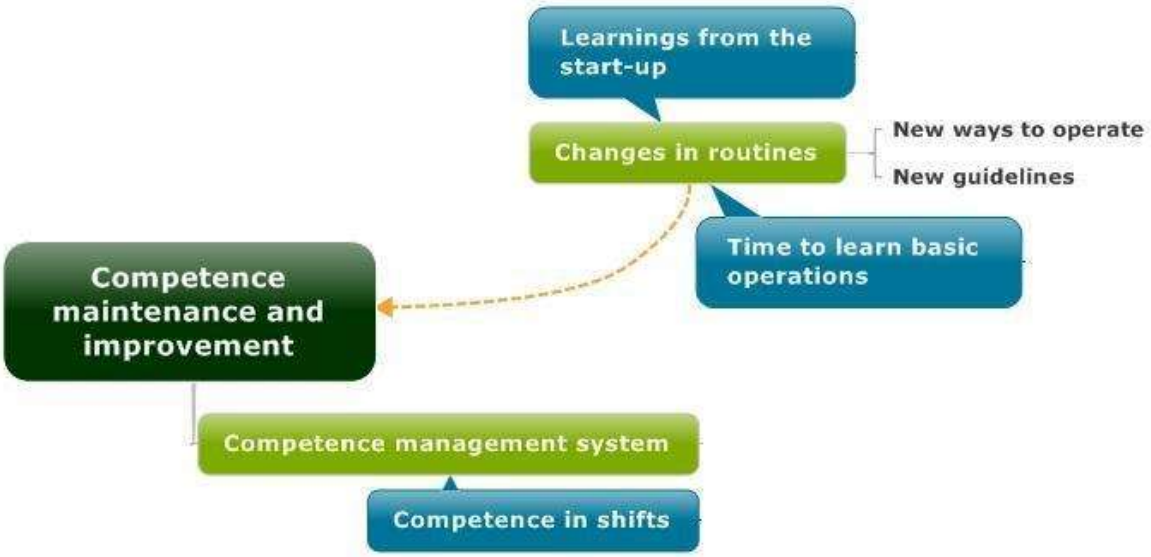

Figure 8 New routine competence after the unit start-up

5 Discussion and analysis

In this chapter, I discuss empirical findings in relation to the literature review. My study contributes to the routine research by examining routine emergence, and the managerial role in the process. These two perspectives have not been studied much in the previous routine literature, and are thus identified as research gaps.

5.1 Routine emergence

Three core observations related to routine research in the field of routine dynamics include: 1) action in routines is situated, 2) actors are knowledgeable and often reflective, and 3) routines are stable now (Feldman et al., 2016). My findings support all these aspects, and refine the understanding of new routine emergence.

My study took place at Neste's Finnish refineries that can be categorized as high-reliability organizations (Weick and Sutcliffe, 2007), where work is strongly guided by different guidelines such as safety rules, legislation, and environmental permits. As previous research has conceptualized routines are mutually constituted with other structures such as culture, patterns of coordination or relationships between groups, rules or artifacts (Parmigiani and Howard-Grenville, 2011). Different artifacts took place during the project work and actual operator work in the studied cases: safety issues, worksite arrangements, and legislations guide project work, whereas operator work is guided by operating procedures, instructions, and checklists. The findings indicate that safety culture is not something separate to the routines,

but part of the routine enactment. Safety was enhanced by discussions, observation tours, and risk evaluations.

As the literature review on routines has shown, artifacts are not only part of the routine replication (Nelson and Winter, 1982), but also influence the enactment of routines (Parmigiani and Howard-Grenville, 2011). My findings show that artifacts have an important role in supporting and guiding the daily operator work, but they may also be restricting in some situations, e.g. in disruptions, where adaptation to the situation is needed. My findings enrich the research on the role of artifacts in routine performance. The findings indicate that part of the routine competence is the ability to use guidelines when needed, as well as the ability to adapt or strictly follow them when needed.

In addition, writing style and the level of details included in the guideline matters: in the studied cases it seemed to be important to write the guidelines so that they describe the target in the given situation, and not include detailed descriptions. Weick and Sutcliffe (2007) support the finding that extensive rules and procedures may restrict the routine enactment. Weick and Sutcliffe (2007) brought up an example of maintenance workers who could not complete a task, since there did not exist a procedure covering the specific situation. However, my study indicates that in some situations a detailed description is needed if certain operations need to be completed in a specific order. Similarly, Danner-Schröder and Geiger (2016) came across that codification of guidelines varied depending on the perceived stability or flexibility of the routine: artifacts codified either the workflow or the task in principle.

Neste conducted the project work in close cooperation with Neste Jacobs in all the studied cases. Since the operations are not pre-defined, and may include ambiguities it was seen essential that the different project actors regularly discussed, and brought up their notions and experiences. As in the SDA project, shared workspaces enabled smooth discussions between the actors, both inside the Neste project group and with Neste Jabobs project participants. However, shared workspaces, as artifacts as such did not ensure regular communication. By building on the concept of mutually constitutive relationship between artifacts and actors (Reynaud, 2005), the findings indicate that communication, knowledge sharing and team building require effort and planning. Both formal and informal meetings are needed; it seems that formal meetings work as the basis for the routine planning and have a critical role in the process, but informal meetings have a supporting role in the process.

The findings demonstrate that operator involvement is highly important starting from the early phases of the project. “Building your own house” was seen as descriptive representation for the operator involvement during the project. Along with the project work, operators get a deep understanding of e.g. a new unit, and they want to build it as good and safe to operate. Then the operators are able to share the knowledge to other shift operators. However, it was emphasized that knowledge sharing between shifts as well as between project operators and working shifts does not happen without planning and allocated time but is something that needs to be planned.

My findings indicate that new routine emergence takes place both during and after the project. During the project, different project actors, such as commissioning manager, production

supervisor, plant supervisor, plant engineer, and project operators, define the routine content. This requires consideration of the bigger picture: what are the remaining, changed, new, and unlearned routines. Especially planning the new routine is somewhat challenging since the new unit may include unfamiliar processes and technology, and operators may not have experience of the specific operations. Weick and Sutcliffe (2007) brought up similar notion that in novel situations people cannot rely on routines, and not all the possible situations can be covered.

Accordingly, competence in routines in disruptions was seen challenging. The study indicates that disruptions and other deviations require that besides operators act mindfully (Langer, 1989) in disruption, they need to develop ability to confront surprises and make informed decisions during the first moments of the disruption. Weick and Sutcliffe (2007) and Weick et al. (2008) who emphasize the importance of act mindfully in high-reliability organizations, and capability to discover and manage unexpected events support this.

In addition, in the planning of trainings, the findings indicate that it is crucial to involve operators both in the planning of suitable training methods and in the content creation of the actual trainings. SDA project operators where highly involved in planning the trainings and creating relevant content from the operator's perspective. The findings show that operators learn a lot when they conduct different tasks during the project and conduct field tours at the construction site. Thus, learning is not something separate from the daily activities that take place during the project.

There are many training methods at the refineries. The findings show that both practical and theoretical training is needed in order to get a profound understanding of the new routine. It

seems that simulator trainings are one of the most efficient ways to learn the new routine. More and more e-learning is also used; however, the findings indicate that it is important to consider in each case what kind of training is the most suitable one. The findings show that e-learning courses work in many cases as a supportive learning method, but besides them practical training and common discussions are needed.

The biggest issues seemed to be, how to train new routine competence during the project when nothing concrete exist. This was seen challenging in the projects since at existing units learning takes place in the form of a direct instruction where e.g. an experienced operator works as a work instructor. In addition, there is always some uncertainty related to new technology and equipment. In the studied cases, one way to tackle this challenge was the use of mental images. In the SDA project, mental images were used to prepare for possible disruptions, and the possible scenarios were discussed together. Training in the form of practicing together has been identified to be critical in the case of interdependent action (Pentland and Feldman, 2008).

Neste has implemented a competence management system that includes unit competence development programs. The findings indicate that the programs are not enough as such, similarly to the notion that designing artifacts is not equal to designing routines (Pentland and Feldman, 2008). New routine implementation requires that the pre-defined content will be transferred into actions, and this was taken into account in the projects. The findings also indicate that the quality of e.g. direct instruction matters considerably.

Project operators formed comprehensive understanding of the process during the SDA project, but also other operators were involved in the start-up activities. During the routine

implementation, attentiveness, ability to understand how the process works against the guidelines and planned routines, readiness to surprises and flexibility in operations are needed. After the start-up the planned routines may change based on the notions made during and after the start-up when operating the ongoing process. Guidelines may be updated and new guidelines created. The interviewees emphasized the importance of knowledge sharing and discussion: all the observations must be written down, and possible changes must be transferred into guidelines. Accordingly, the changes into the planned operations must be implemented and verified so that everyone has the newest operating knowledge.

During the first months, the routines become somewhat established within a shift, and the interviewees brought the importance of shared and systematic practices between the shifts. Previous research indicates that when implementing a new routine it is important to observe the routine after the implementation to ensure that routine is on track or if there are multiple appropriate ways to enact the routine (Pentland and Feldman, 2008).

5.2 The managerial role

All the three studied projects, NCON, SDA, and VRU, which implies that the projects required new working procedures and changes in the company culture. As previous research has shown, change does not happen just by implementing new technology (Edmonson et al., 2001) and related guidelines but requires action (Pentland and Feldman, 2008). The previous research has shown that successful technology implementation required technology framing as a fundamental change instead of a plug-in technology (Edmonson et al., 2001). The need for

fundamental change was emphasized at the company, especially in the NCON and SDA projects.

The role of systematic planning and collaboration was seen to increase in the studied cases to enhance operational reliability. Accordingly, changes did not take place only within specific units but required new models of working together and sharing information. Edmonson et al. (2001), who found out new technology required remarkable changes in the operating room teamwork practices, support this.

The projects differed in terms of work experience the operators had. In the NCON project, a bunch of operators had even tens of years of experience operating the refinery in a specific way. Thus, the NCON was seen to shape the world of operators, which describes the profound effect of the changes on the strongly rooted operations. In the SDA project, many operators were newly recruited or had different backgrounds but also some experienced operators from the same production line were involved. In the VRU project, operators had varying experience but the new process unit in the harbor was very new for all the panel operators, and somewhat new to all field operators. Especially in the NCON case, unlearning was needed: not just unit specific unlearning but also unlearning in general regarding the previously interconnected processes and devices.

Managerial role was seen to ensure that the new routines are implemented by having a mindset of the broader working context. This implies that while enacting the specific routines by operating specific equipment, operators also have a picture of the interconnected units, and of the interconnected operations between different departments. Thus, consideration of all the

changes, and what they mean in terms of competence is needed. For example, in the VRU project a new process unit was implemented simultaneously with a new automation system, and in the SDA project a new SDA unit implied changes in the PL4 and tank farm operations as well. NCON and SDA projects also lead to an increased cooperation between production and logistics department.

Based on the study, different competence requirements take place in each project phase: during the commissioning phase, both project competence and operator competence were needed. Project competence included understanding of the different project phases, and special requirements during the commissioning phase as well as need to follow construction site arrangements and legislation. New competence requirements lead to multiple training needs.

My findings refine the managerial role in planning trainings related to emerging routines. The interviewees emphasized that a proper training plan, including suitable training methods, is something that needs to be done in the beginning of the project. Moreover, interviewees saw it critical that a training plan has been made for each phase of the project. This requires that the management has a comprehensive understanding of the training needs.

Earlier research has discovered that the content of training varied depending on the training principle that was to enhance patterns of standardization, to enhance patterns of flexibility, or to create cross-member expertise and build a team (Danner-Schröder, 2016). My study indicates that the different training content could be divided based on the role of the routine actor: project operator, operator who participates in the unit start-up, working shift operator, or

operator who works at e.g. other production line. The findings indicate that it is essential to train and verify competence of all the target groups.

In the studied cases, the role of training was different between the projects, including the level of planning, operator involvement, and use of training methods. It seems that having a mindset that planning trainings requires effort and knowledge is highly important. Moreover, interviewees highlighted the importance of management showing genuine interest towards operator competence and learning. This is something that seems to take place at the case company.

Operators want to develop the plant to be a good and safe place to operate, so they are motivated to enhance the safety and efficiency of their work. However, motivation during the project work cannot be seen as self-evident but requiring planning as well. The findings indicate that the role of operators in projects must be defined. By giving responsibility and different tasks to operators, their actual involvement is enabled. In the SDA project, operators were given broader goals to accomplish so they were also given freedom to plan the actions needed to reach the target. This is supported by Danner-Schröder (2016) who found out that when squad leaders where given only specific instructions, and not a complete task to accomplish, they did not assess the situation but just started to wait for more instructions and did not have a sense of responsibility.

Since new routine emergence deals with unfamiliar equipment and processes, also support during the project work is needed. Accordingly, Edmonson et al. (2001) identified team communication and psychological safety within the team as key constructs in the technology

implementation process. In addition, is essential that operators have been allocated time to do the project work: the findings show that it is challenging, if possible at all, to focus both on the working shift operator work and project work.

Not everything can be planned during the project; sometimes operators may come across to something unexpected while conducting a field tour and start spontaneously discuss the topic. The findings indicate that these discussions have an important role in the routine planning. Regardless of the fact that not every action can be planned, these kinds of activities at the field may be planned. In addition, the way to share knowledge about the informal discussions and notions that have taken place is something that can be planned, and done systematically.

6 Conclusions

6.1. Main findings and theoretical contribution

Mintzberg and Waters (1985) see strategy process both deliberate and emergent. Emergent strategy implies "learning what works", and suggests managers to be open, flexible and responsive, especially in a complex environment (p. 271). However, managers still need to manage to realize intentions and provide a sense of direction "while at the same time respond to an unfolding pattern of action" (Mintzberg and Waters, 1985, p. 271).

The purpose of this study was to understand routine emergence and the managerial role in routines. The two topics are identified as research gaps in the organizational routine research. In order to understand the emergence of routines and the role of management in routines, I formulated the following research question and four sub-questions.

RQ: How do routines emerge in the refining industry and how the emergence is managed?

a. What phases can be recognized in the routine emergence?
b. What factors affect the routine emergence?
c. What is the managerial role in the process?
d. How to verify competence in routines?

The study was conducted as a case study, including three embedded cases: NCON, SDA, and VRU, that are Neste's change projects to increase profitability or meet environmental regulations at the refineries. The three projects lead to new ways of functioning, indicating that some existing operating routines remain, change or need to be unlearned, and some new

routines emerge. The projects differed by the context: NCON is a large-scale project that aims to change the Naantali refinery configuration, in the SDA project a new process unit was constructed at the Porvoo refinery, and the VRU project included the construction of a first process unit at the Porvoo harbor.

This study has two theoretical contributions: new routine emergence and the managerial role in routines. First, the study reveals that routine emergence consists of three main phases: routine content definition, routine learning, and routine implementation in practice. The findings show that routine content was defined in all the cases, but the level of planning related to the routine learning varied between the cases. Operator involvement starting from the beginning of the project work was found to be critical in routine emergence. Interestingly, operators acquire a comprehensive understanding of the process during the project work, but still a considerable part of learning takes place during the unit start-up, and during the first months after the start-up. Organizational structures such as culture, and different artifacts enhanced or restricted the routine emergence. Safety culture and shared offices enhanced the routine emergence, but e.g. detailed instructions were seen to restrict adaptation that is needed in many operations.

Second, the study shows that the routine emergence is something that cannot be fully planned since unexpected issues take place during the project, and the process may act somewhat differently than planned. The findings indicate that routine emergence was somewhat planned in the studied cases, and the plans have been updated or changed during the process of routine

emergence. However, in line with the deliberate and emergent strategy (Mintzberg and Waters, 1985) routine emergence is something that should be planned.

The findings indicate that routine implementation in practice was the most challenging one to manage. The study reveals the importance of attentive and flexible approach during this period, since operators cannot totally rely on the guidelines but they need to consider if the process and related operations work as planned. Thus, it was seen critical that the changes to the planned routines were clearly communicated and discussed together, and then verified that modifications to the routines were implemented in practice.

Then, the contradictions between planned routines and enacted routines will lead to modifications in the routine. The study indicates the importance of verifying competence before, during and after the unit start-up in routine emergence. Especially knowledge sharing within and between shifts, guiding but not restricting guidelines, and well-planned training methods, including common discussions about the changes, were seen to enhance competence in routines.

6.2 Managerial implications

As the findings indicate, it is crucial to plan routine emergence. However, in line with Mintzberg and Waters (1985) thoughts, the process of routine emergence adopts elements from the planned and emergent strategy. Then, how to manage something that is emerging, especially when e.g. a new unit is under construction?

Managing routine emergence is essential

The study shows that managing routine emergence is essential in all the identified phases: routine content definition, routine learning and routine implementation in practice. The plan evolves into a more detailed plan when the project proceeds, but right from the start there must be a plan indicating what the project and related changes mean in terms of competence in routines.

Similar to the emergent strategy (Mintzberg and Waters, 1985) open, flexible and responsive approach is needed, especially when operating in a complex environment such as a refinery. In addition, besides having the overall plan, competence-related responsibilities should be clearly defined between people. Moreover, involving routine actors in each phase of the routine emergence is critical in order to develop routines that function in practice.

Routine content definition extends beyond a specific routine

Since many routines are interrelated, new routines or changes in existing routines may imply changes to other routines as well. It is of utmost important to consider all the effects within a specific function and across functions, and update the content of the other routines as well if needed. Moreover, it is important to evaluate the scope of the change: if the change should be framed as a fundamental change and not only as an add-on. Even small changes in routines may imply that a comprehensive change approach is relevant.

Well-planned trainings enable and enhance routine learning

In general, learning is seen important in companies. However, planning trainings requires a great effort since relevant training methods and training content that is targeted to a specific audience enables learning. When planning new routines, also a training plan should be part of the official project documents. In addition, discussions within the project actors as well as between project actors and other actors work as trainings by enhancing routine understanding. It is recommended to plan how the actors meet and systematically discuss. Moreover, it is important that management "walks the talk" by being genuinely interested in the learning process, and showing the interest through concrete actions.

Routine implementation implies changes to the planned routine

Regardless of the notion that trainings prepare for the routine implementation, actual learning takes mainly place when the planned routine is implemented in practice. In general, not everything will go as planned and changes take place when routines are implemented. Thus, a defined path for the changes that occur during and after the implementation is needed. This means a clear way to bring up observations, person in charge for changes, and channel to share the new knowledge. In addition, a systematic approach is needed to verify that the change in the routine is understood and implemented in practice. Besides employee's motivation and responsibility, supervisor has a central role in developing the employee competence further, which can happen by giving different tasks and responsibilities.

6.3 Suggestions for further research

This study examined routine emergence and managerial role in routines. Previous research does not fundamentally describe the routine emergence, and the role of management in the process. Thus, my study shed new light on the two topics, but further research is needed in the area. Next, I present two possible topics for further research.

First, **an ethnographic field study observing the new routine emergence** would enrich the topic. My study included the method of participant observation, including also direct observation to a limited extent. However, since the timeline and scope of this study did not enable profound observation of the actual routine emergence process, an observation study would deepen the understanding of routine emergence.

Second, **a comparative study focusing on the roles of routine actors and management in routine emergence** would deepen the understanding of different roles in the routine emergence. This study demonstrated the important role of both routine actors (process operators) and management in routine emergence. The focus of the future study could be on the decision-making process when planning routines. In addition, an interesting aspect would be to examine what is the role of actors and management during the routine implementation when possible modifications to the routines are made.

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Appendix I: Interview guide

Investment projects (such as NCON, SDA and VRU) lead to new ways of operating e.g. a unit or equipment. Competence assurance means learning new work practices/routines, and verifying competence.

1. Would you present yourself, work background and current work task at Neste?
2. Who have participated in the NCON/SDA/VRU project? How have they participated in the project?
    a. How does this affect competence assurance?
    b. How operators have been involved/should be involved in the projects?
3. Neste has introduced new systematic way to ensure refinery competence (competence management project). How do you see the role of competence management system as part of operator competence assurance?
4. How operator competence has been verified/will be verified in the NCON/SDA/VRU project?
    a. Who has planned the practices?
    b. Formal practices
    c. Informal practices
5. Timeline in competence assurance: What has been done/will be done before, during, and after the deployment?

6. How is operator competence in disruptions verified?

7. How should new operator competence be verified if you think about your experiences in the NCON/SDA/VRU project or in general? What are good methods?

8. In which competence assurance practices is room for improvement, if you think about your experiences in the NCON/SDA/VRU project or in general? What has not worked?

9. What challenges are related to competence assurance when operating a new device or unit?

10. What is important to take into account when creating a new work practice / operating model if you think about your experiences in the NCON/SDA/VRU project or in general? What are the critical steps?
11. How do you see the role of shift work/interaction in operator work?
12. How do you see the role of line management and superiors in operator competence assurance?
13. How do you see the role of upper management in operator competence assurance?
14. What kind of attributes and skills are important in the operator work